PLANT PROTECTION IN TURKEY, IRAN, AFGHANISTAN, AND PAKISTAN

A Multi-Disciplinary Study Team Report

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INTRODUCTION

The trip on which this report is based began on September 5 and terminated October 15, 1972. Although much valuable information was gained in the countries visited, the short stay in each was hardly sufficient to achieve a detailed comprehension of all the complex problems impinging on plant protection in the region studied. Moreover, the Study Team was obliged to formulate its opinions and recommendations not on first-hand knowledge of the issues, but rather on information which various persons in the countries related to its members.

As the study was nearing completion, the extreme diversity of agricultural and related technical development represented among the 4 countries became quite apparent. As a result, the Team found it impossible to prepare an integrated report on the region as a whole. Instead, we have attempted to focus on each of the countries individually and bring in what general recommendations appear to apply to the entire region at the end of the report.

The Team members wish to acknowledge with gratitude the valuable assistance of all contact persons with whom we dealt during our visits. In all countries and at all institutions we were received extremely cordially and the climate of free exchange of information which prevailed contributed immeasurably to whatever stature this report achieves.

TURKEY

The Study Team arrived in Turkey on September 5, 1972, and departed September 14. Visits were made to 6 regional plant protection research institutes, 3 universities, the Wheat Research and Training Center, the Sugar Institute, the plant protection directorate, and 4 private sector pesticide firm headquarters. Before visiting Turkey we were informed of the presence there of a great deal of talent in the plant protection sciences. This was not an overstatement of fact, for the Team found more depth and balance in all aspects of plant protection than in any of the other 3 countries visited.

Turkey has a population of 37 million and a land mass approximately the size of Texas and Louisiana combined. About two-thirds of the labor force is engaged in agriculture and related occupations. The more important crops include wheat, rice, barley, cotton, tobacco, sugar beets, citrus, pome and stone fruits, grapes, cucurbits and other vegetables, and hazelnuts. Its main exports are cotton and tobacco. Together with a rather highly developed agriculture, Turkey has become a country of heavy pesticide use, particularly in cotton. Regulations relating to pesticides, however, have been carefully conceived and should serve as a useful model for many other countries.

A. Organization and Functions of Plant Protection Agencies

The Plant Protection and Plant Quarantine General Directorate is organized as a branch of the Ministry of Agriculture and is equivalent to other directorates such as Crop Science and Veterinary (Animal) Science. The general directorate has 11 divisions:

1) Plant protection economics
2) Application
3) Quarantine and fumigation
4) Publication and education
5) Foreign affairs
6) Research
7) Materials and equipment
8) Chemicals and tests
9) Equipment and tests
10) Museum of plant protection
11) Administration

In addition, there are 6 Regional Plant Protection Research Institutes. These are located at Adana (established 1931), Izmir (1931), Ankara (1934), Istanbul (1948), Diyarbakir (1955), and Samsun (1958). A chemical and equipment research institute was established at Ankara in 1958 and a biological control station at Antalya in 1968. The 6 regional institutes adequately cover the ecological and agricultural diversity of Turkey.

The Plant Protection Directorate reports that 1400 people are now employed by the Turkish government in all areas of plant protection. Of this total 270 work at the 8 research institutions and include 254 entomologists, plant pathologists, virologists, and nematologists; 12 chemists; 3 zoologists; and 1 botanist. Research workers are employed as assistants, chief assistants, specialists, or chief of laboratory.

Acquisition of the M.Sc. degree is required for the specialist and chief position. Acquisition of the Ph.D. is encouraged. Foreign language competence is encouraged at all levels and required at the higher levels.

Each station has an administrative and technical service (research) section. Most institutes divide the research section into entomology, which includes nematology, and plant pathology, which includes weed science. The Istanbul station also has a residue and analysis laboratory.

Each research institute has many research projects which seem to adequately cover many of the regional problems. A "T" project is a thesis by a staff member and is related to a plant protection problem of the area; "A" projects study the identification and biology of the pest, the extent of infestation, and control methods; "E" projects arise from the Directorate and involve annual pesticide efficacy tests prior to registration. "T" and "A" projects can be suggested by the ministry of agriculture, the extension service at the regional or local level, the researcher or by farmers. Research projects may be planned by University scientists or Institute researchers and they are implemented after approval by the institute's research committee, plant protection commodity working groups and the State Plant Protection Research Council.

Completed research ("T" and "A" projects) is reported in scientific bulletins prepared for institute researchers, and in technical bulletins for extension workers. Farmer bulletins are also prepared in cooperation with extension personnel. Crop protection practices are then implemented in one or more of four ways.

1. Government control programs. In outbreaks (e.g., Senn pest, field mice, locust) where the area is large and farmers cannot protect their crops themselves, the plant protection extension workers apply controls.

2. Governmental assistance programs. The State, in order to introduce a desirable practice or help poor farmers, may provide pesticides and equipment to the farmer.

3. Demonstrations by extension plant protection workers and commercial pesticide companies. These are regarded as the most effective method of gaining farmer confidence and subsequent adoption of the practice.

4. Grower purchase and application or commercial application (e.g., 2,4-D for weed control in wheat).

There are 10 regional and about 50 province-level extension offices. Turkey also has people working at what is termed the county agent level in the U.S. We did not visit any extension personnel but individuals did express concern over what they termed insufficient cooperation between research and extension and excessive involvement of extension in governmental pesticide application activities.

The Team had no conversations with quarantine officials except that an officer of the quarantine service attended an orientation meeting held to inform us about Turkish plant protection organizations and procedures. Copies of the law on plant control and agricultural quarantine, approved May 15, 1957, and as modified September 7, 1964, were provided.

The Law on Plant Control and Agricultural Quarantine provides legal authority for controlling the movement of plants and plant pests into, out of, and within Turkey. The control is exercised by the Ministry of Agriculture with assistance from the military organization, owners of transportation, civil administrators, and private citizens, as needed. We were advised that the quarantine regulations are vigorously enforced.

Quarantine organizations exist at ports in 20 coastal cities and Ankara to regulate materials entering and leaving by sea and air. In addition there are 75 border stations at highways leading into Russia, Iran, Iraq, Syria, Greece and Bulgaria -- nations sharing borders with Turkey.

Although the regional research institutes do seem to have many of the important problems identified, they do not appear to be functioning at optimum capacity in terms of research productivity. Improved relationships between the private sector pesticide firms and the regional research institutes would be beneficial to each. In 3 cases (Adana, Izmir and Ankara) the institute is located near the agricultural faculty of the university. Too often workers in the same discipline would not know what their colleagues at the adjacent institution were doing. Moreover, workers at one institute do not seem to have adequate contact with those with similar interests at other institutes. Professional jealousies appeared to be somewhat of a problem, with workers at one institute appearing to have limited confidence in the abilities of their counterparts at other institutes. The Team received the impression that the Wheat Research and Training Center, which is attempting to bring about the improvement of wheat production throughout the country, was considered to be an intruder on the Turkish regional research system.

Thus, the greatest deficiency in the organization seems to be a clear definition of the most important problems and a coordinated effort by all sectors to solve them. This is not to imply that all sectors or institutes should be doing the same thing but rather that overall coordination of the effort is lacking.

B. Training and Research Resources and Capabilities

Of the 4 Faculties of Agriculture in Turkey the Study Team visited those at Ankara, Ege (at Izmir) and Adana. Attaturk University at Erzurum was not visited.

In plant protection curricula, entomology and plant pathology receive major emphasis. Although the staff members at each of the universities are involved in teaching and research the relative emphasis on these 2 areas varied. At Ankara, the oldest of the Faculties, teaching received

the highest priority, while at Adana, which was founded only a few years ago, research is emphasized. At Ege the staff divides its time about equally between teaching and research. Students may work toward a B.S., M.S. or Ph.D. degree in several of the plant protection sciences at these Universities.

Work in nematology is offered in entomology and weed science in plant pathology. Only at Ataturk University is there a trained nematologist in a Faculty of Agriculture. Elsewhere a student could prepare a thesis in nematology under the direction of a professor of entomology. There were no courses or trained faculty members in weed science at any of the Faculties visited, but Ankara plans to offer a course this year.

Most staff members had received their educations in other countries, including the United States. Because so little scientific literature is in Turkish and because only a few of the staff members were truly fluent in foreign languages, many staff members had tended to become unfamiliar with current literature. Shortages of adequate library facilities also contributed to this problem.

The laboratory buildings and space allocations did not limit research or teaching activities. In some laboratories there was sufficient equipment and supplies but the equipment was frequently not usable because of broken or malfunctioning parts. The output of all the laboratories could be increased if there were funds and means to acquire small and inexpensive specialized equipment and chemicals.

Facilities for growing plants and microorganisms were generally poor. Most laboratory incubators did not work and greenhouses were either absent or constructed so that adequate temperature control was impossible and thus high temperatures rendered the greenhouses useless most of the year. Problems with these facilities seriously hamper plant protection efforts.

Collections of books and journals in the Faculties were extremely limited. At the new university at Adana most library work had to be done at the nearby regional research institute where there was a fair collection of recent journals. Scholarly studies by students or faculty members were greatly hindered by the lack of library facilities and by staff members' inability to read foreign languages, especially English.

The Regional Plant Protection Institutes have the potential for doing excellent plant protection research. The employees were trained in universities in Turkey and foreign countries and appeared capable of doing the kind of research work needed in Turkey. Much of the research was on chemical control with little effort being given to development of resistant varieties or other control measures. The concept of integrated control was appreciated but little research was being done.

C. Pesticides

There are 8 pesticide formulating firms in Turkey which either import technical pesticides and formulate finished products in the country,

import the finished products directly, or manufacture the technical material and formulate the finished product entirely within the country. Several firms carry on these activities concurrently. DDT and BHC are the only technical pesticides manufactured in Turkey.

The 8 pesticide formulators sell directly to pesticide dealers, and not to farmers. There are 5000 dealers in Turkey but only 3500 are functional at this time and indications are that this number may be reduced. Dealers must be registered by the government and certain minimum schooling and familiarity with pesticides is required. Dealers sell directly to farmers but carry on no demonstrations of products in farmer's fields. Products of several formulators often are carried by a single dealer. Some promotional work and demonstration is undertaken by formulators.

The Ministry of Agriculture maintains tight control over pesticides, apparently because of the toxic nature of many of these compounds and the fact that most are used by poor and illiterate farmers. Prices are set by government for pesticides and for custom application. We found that the formulators in general believed that they were not getting a fair return on their investments because of government pricing policies for pesticides. Several formulators remarked that the margin of profit was higher for pesticides imported in an already formulated state, and the trend is toward less formulation in the country. However, the government may prohibit the importation of a low percentage pesticide because of the high cost of importing inert ingredients. Government may also prohibit the importation of a particularly high priced pesticide. A Central Pesticide Registration committee determines what pesticides will be permitted in Turkey.

In order to obtain a selling license for a pesticide each formulation of the material must be registered by the government. Samples of the formulation are first submitted to the Plant Protection and Plant Quarantine Directorate by the formulator. These are divided and sent to several or all of the 6 regional plant protection institutes, depending on the pests for which registration is sought. The formulator recommends to government the tests which should be conducted, based on preliminary trials often conducted by the company in Turkey. However, such company tests currently have no status in the registration process. If, after field tests are conducted at the regional institutes, favorable results are reported from each of 2 institutes, or, if 2 favorable reports result from the same institute in 2 consecutive years, a selling license normally is granted. Some testing for residues, purity, physical properties, etc. is also conducted by several laboratories of the Plant Protection and Plant Quarantine Directorate before the selling license is granted, and periodic checks are made from samples taken from store shelves after registration to verify the quality and shelf life of pesticides being marketed. The selling license may be withdrawn if the product is found deficient.

After the government has issued the selling license, the formulator prepares his own label. This lists the several pests toward which the regional institutes directed their tests, but it may also include 10 or

15 other pests which the formulator maintains will be controlled by the product, but which have not necessarily been included in the regional plant protection institute's field trials. There is no regulation of labelling by government at present but it is planned. In the event of non-performance or plant injury, government is liable for the several pests on the label which were included in institute tests, and the company remains liable for the insects not included in the government tests.

The private sector believes that the government acts too slowly in conducting the tests necessary for the granting of the selling license. This may require 2 to 3 years. Clearly the regional institutes do not have the time and manpower to conduct all the tests as quickly as the private sector would like. Formulators cannot make grants to the regional institutes to expedite tests, and the institutes are the only institutions authorized by law to conduct the tests.

Lists of recommended (or, more accurately, registered) pesticides are published by the regional plant protection institutes. These become the recommendations of the extension service. Variances exist from region to region in the pesticides recommended for particular pests. When pest resistance to a chemical is established, the material is withdrawn from the recommended list.

We found, among 5 firms interviewed, a general lack of interest in integrated control of crop pests. All seemed aware of the concept of integrated control, but most believed that in the present business climate, their interests were best served by maximum sales. There appeared to be some uncertainty about what governmental constraints might be placed on them in the future. Several commercial representatives remarked that if the business climate were improved, they would be much more interested in regulating the flow of pesticides in order to delay the development of chemical resistance by pests, and to preserve markets for their products. The cotton market was cited as a specific example.

The registration process is under review at present by the government. In all likelihood a classification for pesticides, based on their toxicity, will be established and appropriate labeling will be required. Also, a label review process will probably be initiated in order to be sure all pests listed have been subjected to field control tests in Turkey. This may result in company tests being given weight in the registration process.

Quantities of locally formulated pesticides, in terms of finished products, but excluding sulfur and copper pesticides, are shown in the following list:

Year	Metric Tons
1969	32,000
1970	30,000
1971	26,000

The apparent decline in usage over these 3 years is reportedly due to the

decrease in hydrocarbon use and the increase in organophosphate pesticide use, and the fact that the latter are commonly formulated as higher percentage products. If sulfur and copper pesticides are included, the usage figures for the same years are as follows:

Year	Metric Tons
1969	44,000
1970	48,000
1971	45,000

Figures on imported finished products are given below:

Year	Metric Tons
1969	1,000
1970	1,874
1971	2,982

Insecticides accounted for 79% of all pesticides sold in Tuekry in 1971. Fungicides, herbicides and nematicides followed in approximately that order, with some variation from firm to firm. Cotton accounts for about half of all pesticides used in Turkey, and the majority of these materials are directed against Prodenia and spider mites. Most insecticides are used in the Adana cotton region, where 8 to 11 annual applications are commonly made. Following pesticide use in cotton, the following commodities, in approximately the order shown, account for much of the remainder of the pesticides consumed.

Fruits	Sugar beets
Vegetables	Hazelnuts
Tobacco	

Several firms report that nematicide sales are increasing more rapidly than sales of herbicides.

Government restricts the use of certain pesticides. For example, DDT can be used only for a few cotton pests, for olive moth, and for control of Senn pest (Eurygaster integriceps) on cereals in an early stage of growth. Dieldrin and aldrin can be used only for seed dressings for cereals and cotton. Toxaphene has been banned for all crops. Certain foliage oils are the only materials authorized for use on citrus in order to benefit biological control. In times of crisis, however, restrictions on citrus may be lifted. It is freely acknowledged that restricted pesticides are often used on crops other than those authorized, for means of controlling pesticide usage is not adequate. Government does make spot checks for residues on export crops in an attempt to discourage unauthorized pesticide use. Crops consumed locally are not checked for residues although government has indicated a desire to improve its capability in this area.

The Study Team was favorably impressed by certain constraints which the Turkish government has imposed on the formulators. We are aware that unrestricted pesticide use in a number of developing countries has resulted in serious exploitation of farmers, who in general are not well acquainted with the intricacies of pest control. In some cotton-growing countries, indiscriminate use of pesticides has led to this crop becoming unprofitable to produce because of ever-increasing needs for pesticides due to chemical resistance and the appearance of secondary pests resulting from destruction of natural enemies by pesticides. On the other hand, restrictions on Turkey's formulators must not be so severe that they are unable to achieve a fair profit on their investments. The Turkish formulators have formed a pesticide association, which they expect will allow them to take their collective grievances to government in an attempt to assure that fair profits can be realized.

D. Weed Science

With the exception of the USAID project on weed control in wheat, nearly all of the weed control research in Turkey is being conducted at the plant protection directorate's regional research institutes. At these institutes Turkey, like most other countries of the world, gives far more emphasis to other aspects of plant protection than to weed science. Most of the research now underway is conducted as an "E", of herbicide testing, project, thus creating a great deal of emphasis on the use of herbicides to solve weed problems. Herbicides may prove to be the best solution in many cases but we found few examples of research on weed physiology, ecology, competition, and control by cultural or mechanical means.

At all ranks and in all stations there are 14 people working on weed control. Most of these have been trained as plant pathologists. There are a few people in the private sector with training in weed science. Those engaged in weed control were aware of many important weed problems but the research underway must become broader in scope and oriented toward solving a weed problem rather than merely testing 1 or 2 herbicides. To broaden their appreciation of weed control and their knowledge of weed science, Turkish workers should have a greater opportunity to discuss weed problems and solutions at the national level. Some attend the annual research meeting of the Plant Protection Directorate in Ankara, but we question whether there is adequate opportunity for weed science discussions between all concerned sectors. As an example, one Team member was asked for specific information on a subject and he later met a Turkish scientist at another institution who had done extensive work on the subject. Neither man knew of the other.

The Plant Protection Department of the Faculty of Agriculture at Ankara University will offer a course in Weed Science in 1972-73. This will be the first and only course in the country. There is no one in the university system who has had specific training in Weed Science.

There is a conspicuous absence and even awareness of the literature of Weed Science. The best resources were individual collections but library collections of textbooks were meagre and old, and journal

collections were even poorer.

The use of herbicides to displace hand labor for weeding crops was discussed extensively. The opinion of the Plant Protection Directorate is that it recognizes this possibility but as agriculture modernizes, it considers the displacement of labor to be inevitable and is not overly concerned. Herbicides now represent only 7.5% of the total pesticide sales but the private sector expects this to grow. Most of this sales volume is for phenoxy acids on small grains which are difficult to weed by hand. Herbicide use will probably expand most rapidly in corn, cotton and sugar beets, all of which are major crops. Migrant hand labor is now used extensively in cotton and sugar beets and is becoming more expensive each year. Sugar Institute research personnel have studied chemical weed control and are ready to rapidly make the shift. However, until the industry changes from multigerm to monogerm seed, hand labor will be necessary. The cotton grower uses hand labor for thinning and harvest. The problem becomes one of determining the most profitable employment of available resources. Hand labor is still the most economical method for most growers. None of the plant protection institutes is studying the economics of weed control by various means.

There are 27 different herbicides registered for specific uses. These represent a wide array of products whose uses have not been fully explored by all research workers. This arises because of registration for limited use and an unawareness of the applicable literature which combine to inhibit full realization of a compound's potential.

The principal weed problems are listed by crop in the following table. Each problem is assigned a rating on a scale of one to four:

1. Serious problem - No good solutions available
2. Serious problem - Some control possible with present technology
3. Serious problem - Good solutions available
4. Could become a problem but control techniques are well known and could be adapted with little research

Principal Weed Problems in Turkey and Their Importance in Crops

Scientific Name	Common name	Crop(s)*	Control rating
Alhagi camelorum Fisch	Camelthorn	4,10	2
Amaranthus viridus L.	Slender amaranth	2,9	3
Avena fatua L.	Wild oal	2,3,10,11	2
Boreaba orientalis L.		11	2
Bromus tectorum L.	Downy brome	11	1
Centaurea solstitialis L.	Yellow starthistle	11	4
Chenopodium album L.	Lambsquarters	2	3
Convolvulus arvensis L.	Field bindweed	7	1
Cynodon dactylon (L.) Pers.	Bermuda grass	1,3,4,9, 10,11	1

Scientific name	Common name	Crop(s)*	Control rating
Cyperus rotundus L.	Purple nutsedge	1,2,3,5,6, 7,8,9,11	1
Digitaria sp.	Crabgrass	3	2
Echinochloa crus-galli L. Beauv.	Barnyard grass	2,5	2
Euphorbia sp.	Spurge	9	4
Galium aparine L.	Bedstraw	6,7,8	1
Heliotropium sp.	Heliotrope	9	4
Matricaria maritima L. var. agrestis (Knaf)	False chamomile	6,8	4
Papaver rhoeas L.	Corn poppy	7	?
Philipaea ramosa	Orabanche	9	1
Portulala oleracea L.	Purslane	2,3,9	2
Ranunculus sp.		7	3
Salsola kali L. var. tenuifolia Tausch	Russian thistle	4	3
Sinapsis or Brassica arvensis	Field mustard	7	3
Sonchus sp.	Sow thistle	10	2
Sorghum halepense L. Pers.	Johnson grass	1,2,3,5,6, 7,9,10	1
Tribulus terrestris L.	Puncture vine	4,9	2
Vicia sativa L.	Common Vetch	7	4
Xanthium macrocarpa L.	Big cocklebur	6,8	3

* Crops indicated by key number

1. Citrus orchards
2. Corn
3. Cotton
4. Fallow wheat land
5. Rice
6. Soybeans
7. Sugar beets
8. Sunflower
9. Tobacco
10. Vineyards
11. Wheat

E. Nematology

Plant-pathogenic nematodes are causing severe yield reductions in important crops in Turkey. These include Anguina tritici on wheat, Tylenchulus semipenetrans on citrus, Ditylenchus dipsaci on onion and garlic, and Heterodera schachtii and Meloidogyne sp. on sugar beets. It is generally recognized by Turkish nematologists that these are only the most obvious nematode-induced diseases and that many more will be recognized when more research is conducted. For example, although numerous ectoparasitic plant-pathogenic nematodes, such as Tylenchorhynchus sp., Longidorus sp., and Crieonemndes sp. are often extracted from soil samples, their roles in root destruction of crop plants of Turkey is unknown. The nematode Xiphinema index transmits fan leaf virus of grapes. Undoubtedly other important virus diseases are transmitted by nematodes in Turkey but little or no research has been conducted on this subject. The cyst nematode Heterodera avenae causes destructive yield losses to wheat in Tunisia. Cysts thought to be H. avenae, but not yet positively identified, have been found in wheat, the most important food crop in Turkey.

A nematologist was on the staff of 5 of 6 of the Regional Plant Protection Institutes. Four received most of their training at Turkish universities, with brief additional training periods in the U.S.A. The fifth received a Ph.D. from a U.S. university.

Research in nematology consists chiefly of comparing the performance of nematicides in field tests and identifying nematodes associated with crop plants. There is very little research conducted either in greenhouses or in controlled environmental chambers. Because faulty construction makes it impossible to maintain temperatures sufficiently low for good plant growth, a number of relatively new greenhouses are not being used for research. Most experiments are conducted on grower-owned land. There is little testing of crop varieties for nematode resistance and few experiments on the effects of crop rotation or other cultural practices on nematode populations.

Considerable progress has been made in nematology during the past decade. Additional nematologists have been employed and a number of important nematode diseases identified. However, there are probably numerous as yet unrecognized nematode problems, especially those caused by nematodes which do not cause diagnostic plant symtoms and root destruction caused by the combined activities of nematodes and microorganisms such as fungi and bacteria. Considerably more field and greenhouse tests should be conducted to determine the extent of nematode damage in Turkey.

Anguina tritici, which is relatively easy to control by one-year fallow and removal of nematode infected galls by salt flotation from seed, is thought to be causing considerable yield losses in wheat. In cooperation with extension personnel efforts should be made to determine the distribution of this nematode and to teach growers with infested land to control it.

There is some evidence that the destructive cereal cyst nematode is present in wheat growing areas of Turkey. Surveys should be conducted to find more information on the distribution of this nematode.

A number of Turkish nematologists would benefit from additional training for 1 or preferably 2 years at a university in the U.S.A. It is probable that nematologists who have finished a Ph.D. degree in Turkey and have had several years work experience would receive the greatest benefit from 2 years post-doctoral training in the U.S.A. Most nematologists need aid in purchasing small items of specialized nematological equipment; very little expensive equipment is needed for research in nematology. Help is needed in designing greenhouses in which reasonable temperature control can be achieved with the lowest possible cost. For most types of nematological research such greenhouses would be more suitable than controlled environmental chambers which have a high initial cost and are difficult or impossible to maintain, especially at relatively isolated locations. Additional funds to purchase the increasingly more expensive nematology books and journals are needed.

F. Plant Pathology

In Turkey, plant diseases are recognized as limiting production of crops and considerable effort is made to understand and control them. An outstanding example is the control of blue mold of tobacco with resistant varieties of tobacco.

The fungi are considered to be the most important pathogens with viruses being second in importance. Most effort in research and control is being given to the foliage fungus diseases because they are prominent, important, and most of the pathologists have been trained to work on them. Virus diseases and soil borne diseases are probably more important than is generally realized and while some work is being started on these problems the effort should be greatly increased by training more students on these problems and by intensifying research. Faculty staff members have no responsibility to do mission-oriented research nor to be involved in extension. Consequently the pathological studies tend to be academic. When studies are directed toward disease control, they emphasize chemicals and cooperation in plant breeding programs is virtually non-existent.

The following is a list of diseases on the major crops: wheat, stem rust, stripe rust and leaf rust; rice, blast; citrus, nutrient deficiencies and virus diseases (most of them), phytophthora root rot; pistachio, septoria leaf spot; tobacco, downy mildew; pepper, virus diseases; cotton, pythium and fusarium root rots; hazelnut, bacterial blight.

Research is being conducted on all of these diseases and many others. While the work done appears to be of good quality, there needs to be more coordination among all of the research organizations. The benefits from a coordinated national research scheme can be seen with the control of blue mold of tobacco by resistant varieties developed by breeders and pathologists working together. Wheat is presently being studied in several locations by breeders and pathologists working together. These projects could perhaps serve as models for other crop studies.

Education and Training: The centers of training and education in Plant Pathology are in the Faculties of Agriculture at Adana, Ankara, Izmir, and Erzurum where undergraduate and/or graduate training is given. The undergraduate education appears to be of good quality in that a well rounded program is presented in biology, physical sciences and social sciences.

The graduate programs are similar to the American system in that coursework is required. The thesis may be prepared while in residence at a university or while working at a facility away from the campus. In the latter case, supervision by the advisor is difficult and minimal. The research therefore tends to be somewhat routine and superficial and the quality varies greatly with individual students.

The academic staff in the Faculties of Agriculture appear to be well educated and qualified for their work. Many hold doctorates from American

or European universities and a few have doctorates from Turkish universities. Their work suffers because of low salaries, poor equipment or lack of it, lack of supporting staff, and inadequate budgets.

There is little interest in, nor are the facilities available for, superior research under field conditions. There is little being done on sanitation, cultural practices, or other measures to control disease. While integrated and biological control of disease were often mentioned as areas of interest, no work was observed.

Research capability: Research in plant pathology is done at the Faculties of Agriculture and at the Regional Plant Protection Research Institutes located throughout the nation. There is little coordinated research between the universities and the Institutes, though there seems to be no official barrier to it. An exception to this is the thesis research done at Institutes by Institute staff members who are also graduate students at a university. Even in these cases, however, Institute staff appeared to have little to do with the supervision of the research.

At the Institutes the emphasis is on applied research. Most projects terminate within 3 years but some continue up to 7 years. Evaluation of chemicals is a major activity. The next most important area of study is concerned with the biology of pathogens and etiology of disease.

The plant pathologists at research institutes appeared to be well qualified to do their work. Some hold doctorates from the U.S.A. and Europe and many hold M.S. degrees from Turkey. All workers were well trained in basics of plant pathology and were working on worthwhile projects.

G. Entomology

Of all the plant protection disciplines, entomology receives more attention than any other in Turkey. The numbers of entomologists in federal service and at universities appeared adequate for the job to be done. Nowhere did the Team receive the impression that additional entomologists were needed; however, the need for additional training of established entomologists was noted at nearly every institution visited.

There seems to be heavy emphasis on chemical control research in Turkey, especially at the federal level. Departures from this include the activities of biological control workers at Antalya, Izmir, and Istanbul. The Antalya laboratory apparently is devoted largely to the rearing of Cryptolaemus for mealybug control on citrus, but projects have recently begun there on an encyrtid parasite of the citrus mealybug and a braconid parasite of a citrus moth. Numbers of workers at these biological control laboratories are very few, however, and virtually all of their activities are directed against a single crop -- citrus. Since cotton is the crop against which most pesticides are directed, it would seem worthwhile to devote additional entomological effort to biological and integrated control research on it.

Control of the Senn pest (Eurygaster) occupies a great deal of entomological effort each year. The government carries on an aerial control program when a population of 1 bug/square meter appears in the wheat fields in the spring. As many as 600,000 hectares of wheat have been sprayed in a single year for control of this pest, with highly successful results.

The following is a listing of the major pests found on the principal agricultural crops in Turkey:

Cereals

- Eurygaster integriceps
- Aelia spp.
- Zabrus spp.
- Aphids
- Wheat stem sawfly
- Margarodes ground pearl
- Mice

Citrus

- Aonidiella aurantii
- Planococcus citri
- Paratetranychus citri
- Saissetia nigra
- Coccus hesperidum
- Ceroplastes floridensis
- Phyllocoptes oleivorus
- Mediterranean fruit fly

Pistacio

- Idiocerus stali
- Psylla sp.

Tea

- Pulvinaria sp.

Potato

- Colorado potato beetle

Grapes

- Lobesia sp. (grape moth)

Alfalfa

- Hypera postica
- Sitona hispidula

Cotton

- Prodenia litura
- Tetranychus mites
- Earias insulana
- Laphygma exigua
- Pectinophora gossypiella
- Wireworms
- Heliothis armigera

Tobacco

- Aphids

Olive

- Dacus oleae
- Olive moth
- Saissetia oleae
- Euphyllura olivina

Hazelnut

- Balaninus nucum
- Eriophyes sp.
- Gypsonoma
- Myzocallis sp.
- Melalontha melalontha

Sugar beet

- Weevils, including:
  - Bothynoderes punctiventris
  - Tanymecus spp.
  - Otiorrhynchus lugustici and others
- Agriotes spp.
- Laphygma exigua
- Chaetocnema spp.
- Gryllotalpa vulgaris
- Pegomyia hyoschyami

Pome and stone fruit crops

Laspeyresia pomonella
Rhagoletis cerasia
Laspeyresia molesta
Tent caterpillar
Cacoscia spp.
Tetranychus mites
Eriosoma lanigerum
Aphids
San Jose scale

H. Needs and Recommendations

1. Better coordination of the plant protection effort. Except for those caused by viruses, soil-borne organisms, and weeds, the important plant protection problems have been reasonably well defined and many sectors are working toward their solution. In spite of this, the regional plant protection research institutes, the extension service, and the universities seem to be going their own separate ways with only a minimal cooperative effort. The Ministry of Agriculture and the Plant Protection Directorate are the key organizations wherein a coordinated program must begin. A clear definition of the roles of each sector and its relationship to all others should be established at this level.

2. Better communication at the working level. We often encountered workers at adjacent institutions working on similar problems with very limited communication or cooperation. This problem was accentuated when researchers were working in different cities. Although we were told that an annual research worker meeting is held in Ankara, our impression is that this does not provide a sufficient opportunity for those doing the research to discuss their problems via presentation of research results as papers or in seminars. Such discourse would contribute to the plant protection program at a minimal cost. Interchange of research progress reports should also be encouraged. The annual report of the Plant Protection Directorate is a step in this direction, but it does not include all of the work in progress.

3. Programs in nematology and weed science should be strengthened. Except at Attaturk University no courses in nematology are offered and weed science will be included for the first time in 1972 at Ankara University. The library and textbook resources in these fields are meager with the exception of a few individual collections. There are no trained weed scientists working at the regional research institutes; however, 5 or 6 did have a nematologist on the staff. In view of the foregoing and the weed and nematode problems identified and anticipated, there are deficiencies in personnel and training in these areas. Research workers are needed at the research institutes and the universities to handle the rapidly unfolding problems of nematodes and weeds.

4. Research programs should be less chemically oriented and more problem oriented. Plant protection research must be broadened to cover all aspects

of pest control. At present the major attention is given to chemical control of insects and fungi with a limited amount of work on the biology of these 2 kinds of pests. The importance of viruses and nematodes must be evaluated and weed studies should be broadened. A coordinated research program should be developed with major emphasis on particular aspects of control being assumed by one institute or university. Thus, areas of pest control such as resistance, cultural practices, development of pest-free planting stocks, fumigation, dates of planting, etc., which are presently neglected, could be adequately investigated.

5. Improved library resources and worker awareness of the world literature in plant protection. Many Turkish plant protection workers appeared to be only partially informed about the scope of plant pest control work being done throughout the world as well as in Turkey. This was largely due to inadequate libraries in most institutions and to the inability of many workers to read foreign languages. Unless such a facility exists and was overlooked by the Study Team, a considerable effort should be made to provide a complete national library resource that will service the library needs for all research, extension and educational units of the country. The resource should include a complete bibliography of world literature, reprints of requested papers, and in many instances summaries in Turkish.

6. Equipment. There is a great need for equipment for doing research, especially small items. Existing equipment was often not being used because a spare part was not available or because no one could repair it. A central organization capable of supplying information on how and where to acquire equipment, spare parts, and directions on how to make simple repairs could do much to help all the research institutes and universities. There is also a great need for adequate greenhouse facilities.

IRAN

Six days were spent in Iran by the Study Team and as a result only a limited number of contacts were made. Of particular value were the visits made to the Pahlavi and Karaj colleges of agriculture, the Plant Pests and Diseases Research Institute, and various agricultural projects of the Khuzestan Water and Power Authority. The Team was favorably impressed by the forward-looking attitudes of those close to the agriculture scene and we were led to anticipate dramatic achievements in the agricultural sector in the 1970's.

Unlike the other 3 countries visited, Iran's economy is based heavily on petroleum. Yet about 60% of the population lives in rural areas. The country has a population of about 28 million. Only slightly more than 10% of the total land is considered arable. The country is largely a semi-arid plateau with high mountain ranges and considerable expanses of barren desert. Principal crops include wheat, barley, rice, sugar beets, pulses, cotton, tobacco, dates, raisins, and tree fruits.

A. Organization and Functions of Plant Protection Agencies

In Iran plant protection has education, research and extension components. Unfortunately these 3 activities are not closely coordinated and joint activities result mostly from individual initiative.

Education: While there are several universities in Iran only the Agricultural Colleges of Tehran University at Karaj and of Pahlavi University at Shiraz were visited. Both have Departments of Plant Protection (Plant Medicine), the one at Karaj being much older. Each offers the B.S. and M.S.; Karaj College will offer a Ph.D. in plant protection in 1973. The staffs are well educated and the laboratories adequately equipped; they should be able to supply plant protection workers for some time.

Research: Plant protection research is done at the agricultural colleges and the Ministry of Agriculture's Plant Pests and Diseases Research Institute at Evin (Tehran) and its 15 substations. The team visited the research center at Evin and found excellent modern facilities and a well-educated staff organized for applied research in entomology, pathology, and nematology. Weed science was considered of minor importance and was largely done at the Safiabad experiment station of the Khuzestan Water and Power Authority.

The research at Evin covers all aspects of plant protection and at present is organized in some 70 projects. At the substations the work is intended to supplement that done at Evin and give attention to local problems. The branch stations are not so well equipped and staffed as Evin.

Extension: The extension work in plant protection is carried out in a separate division of the Ministry of Agriculture. The extension program began shortly after World War II with American assistance. At present there are extension agents in every village. The main weakness of extension is that these workers may be military personnel assigned to extension work.

Plant protection action programs are organized under 3 different categories. The category depends on the seriousness of the problem and the urgency of the need for action.

The categories are:

1. General pests. These are problems of great significance often due to pests arising from outside of Iran. Examples are Senn pest, migratory locusts, rats, and birds. With these problems the government takes all steps to achieve control including surveillance and application of controls and pays virtually all of the costs.

2. Major pests. These are problems that are of more local concern and may involve only one important crop such as cotton or tobacco. The government shares the cost of control with the growers and makes certain that appropriate pesticides are available for the growers to use.

3. Minor pests. These are problems on less important crops or of limited distribution. The government provides information to growers but growers pay control costs.

B. Training and Research Resources and Capabilities

The excellent facilities and well-trained staff members at Karaj College and Pahlavi University College of Agriculture make it possible to increase the number of graduate students majoring in plant pathology and entomology at each college. At present courses in weed science and nematology are offered at Pahlavi University; at Karaj, there is now a course in weed science and one in nematology will be offered in 1973. By adding staff members in nematology and weed science, the course offerings in these subjects could be increased and an M.S. and eventually a Ph.D. program initiated.

All or almost all of the staff members at Karaj and Pahlavi received Ph.D. degrees from European and U.S. universities. Apparently the administration at each college is stimulating high achievement from the staff and recognizes the importance of publications. The enthusiasm and morale of the staff members were high.

The libraries are good and the laboratories relatively large and well equipped. There are experimental greenhouses and land is available to build additional ones. There is also sufficient land at each institution for a sizable field research program.

When appropriate, thesis research could be conducted at the Plant Pests and Diseases Research Institute, Ministry of Agriculture, at Evin. It was judged that space was available for additional research workers in the well-equipped laboratories at this research station.

By the expenditure of relatively modest sums of money, a regional center of excellence for training in all phases of plant protection could be established at either of these universities. Attention must be given, however, to the fact that very little of the world's literature in plant protection is in Persian. Instruction therefore should be given in one of the major languages. At present some courses are taught in Persian and others in English at Pahlavi University.

Students from countries with less advanced training programs in plant protection could be sent to this center of excellence for training. For many students, studying for an M.S. or Ph.D. degree at Karaj or Pahlavi would be more suitable than studying at a university in the U.S.A. or another highly developed country. Limited funds could then be used to enable plant protection workers to pursue postgraduate programs of study in plant protection at a university in the U.S.A. or elsewhere. Preferably such training should be made available after a person with an advanced degree has had several years of work experience in his home country. Such an arrangement would also provide better training in plant protection for Iranian students.

At Karaj and Pahlavi there is an urgent need for middle level technicians with at least a B.S. degree. Such assistance to staff members would increase the effectiveness of both teaching and research.

There is a need for closer cooperation between the Colleges of Agriculture and the Institute at Evin. There is an even more urgent need for closer ties between extension and the research workers at the colleges and the national research stations. Also, staff members at Karaj College expressed the need for closer ties with workers in plant protection at one or more American universities.

C. Organized Agriculture in Khuzestan Province and Relation of Plant Protection To It.

Agriculture has been practiced for centuries in the Khuzestan. In recent decades, it has declined to subsistence farming which was barely able to support the population. In a dramatic attempt to reverse this situation the Mohammed Reza Shah Pahlavi Dam was completed on the Dez River in 1963. The dam and irrigation network are capable of irrigating 125,000 hectares of land. Several major efforts to capitalize on the agricultural potential of the area are now underway. These include:

1. The Dez Pilot Irrigation Project (DPIP). This is the administrative center of the entire irrigation project.
2. The Safiabad research farm.
3. Haft-Tappeh cane sugar plantation.

4. Agro-Industry land lease agreements.
5. Village cooperative farms. Traditional subsistence type agriculture is still prevalent in the area.

Dr. Zimdahl was able to visit all but the village cooperative farms during his stay in the area. The immediate impression is that where modern agriculture and high crop yields were impossible earlier they are now accomplished objectives. The DPIP and the Haft-Tappeh plantation are efficient, well managed, and production oriented schemes. These projects have been adequately funded and outside consultants are used when necessary. The Agro-Industry companies (presently 3) are large, well financed, and production and profit oriented. They employ the best agricultural technology consistent with their stage of development and an appropriate utilization of available labor which is often insufficient to meet peak demands.

The Safiabad research station is adequately housed and financed but not adequately staffed with well trained Iranians. The station does not have a trained entomologist or nematologist on its staff. There is 1 worker in plant pathology and 1 in weed science (plus a U.S. consultant) but it is doubtful that the plant protection research capability is adequate to handle the problems that are present and that will appear with the rapid expansion of modern agriculture. The experiment station has found acceptable solutions to the spiny bollworm of cotton and armyworms and cutworms in sugar beets. However, the Agro-Industry people report that because of the critical timing required and the marginal effectiveness of present treatments, army and cutworms are still major problems in other crops. Perennial grass weeds (nutsedge, cogongrass, Johnsongrass) are difficult and major problems in the area. In summer spider mites are the most important entomologically-related problem but in the winter, when most crops are grown, diseases become predominant. The research station personnel believe that farmers do not recognize disease problems that already exist; these will become more serious as time goes on.

From any viewpoint the vast agricultural potential of the area is just beginning to be exploited. The development to date has been quick and is very impressive. Because of Agro-Industry aid, the sugarcane area is a major user of the pesticides sold in Iran. Adaptive research capabilities are not now sufficient to deal with the plant protection problems and the gap will widen. Solutions to many of the problems can be aided by utilizing the research experiences of similar areas (e.g., California's Imperial Valley). However, local adaptive research is needed. It is already suspected that the indigenous strain of Fusarium is unique and varieties resistant to Fusarium infection in other areas will not express the resistance in the Khuzestan.

Personnel of Development and Resources Corporation of New York have been continuing consultants on all phases of the project. They are aware of these problems and pointed out many of them. In cooperation with the Iranian staff of the Safiabad station and as determined by the

availability of qualified people they are working toward solving the extant problems.

D. Pesticides

All pesticides in Iran are handled by the private sector. No technical material is manufactured in the country; both finished products and technical materials for local formulation are imported.

Insecticides represent the largest pesticide market, followed by miticides, fungicides, herbicides, and nematicides. Insecticide sales are expected to increase greatly for the next 5 to 10 years as a consequence of new dams being constructed and the new agricultural lands which will be irrigated from impounded water. These lands will probably be farmed, at least in part, in some kind of collective scheme and pesticide usage here is always greater than on land farmed by the peasant agriculturist. Herbicide sales are expected to increase dramatically in the next 5 to 6 years and may then be second to insecticides in sales.

Cotton is the largest consumer of pesticides, followed by fruit and nut crops, and sugar beets. On cotton, Heliothis, spider mites, and Earias are the pests receiving most treatments. Citrus receives treatment of oil or oil plus phosphate insecticides for scales, spider mites, and aphids. Scales, codling moth, aphids, and mites are the usual pome fruit pests receiving treatment. Sugar beets are treated for armyworm and caradrina.

Pesticides must be registered before they can enter the country. The company first submits to the Ministry of Agriculture information on pesticide usage, dosage, application and the results of trials with that chemical conducted in other countries. This information normally is provided to the Ministry of Agriculture's Plant Pests and Diseases Research Institute. Field trials are conducted at several of its 15 regional laboratories, and a fee is charged for the conduct of these trials. Company representatives may also conduct field trials in Iran but the results of these have no status in the registration process.

Field trials by national plant protection workers are usually directed against 2 or 3 important pests. The company label, however, may list more insects on the label, even though no trials were conducted against many of these. The Plant Protection Department in the Ministry of Agriculture has as one of its functions the review of approval of labels; it may not approve the listing of one or more pests on the label if there are doubts about the effectiveness of the product against that pest.

The company is allowed to put on pesticide demonstrations in farmer's fields, and the company can sell directly to dealers, farmers, and the government for its pest suppression programs.

Residue sampling is not a part of the registration process and

residues are not monitored on crops. It is not generally believed that residues are a problem because most food crops are not widely sprayed. The Ministry of Agriculture checks samples of pesticides for quality periodically after registration.

The government fixes the selling price of all pesticides and allows a 20-25% profit on each product. Reselling price to the farmer is not subsidized by government.

A pesticide association is being formed in Iran in order to allow the chemical companies to collectively bring their grievances to the government. Based on our small sample the chemical industry does not appear to have serious grievances with the government. The opinion was expressed that some poor insecticides are quickly allowed into the country, while some excellent ones are refused entry.

Some evidence of pesticide control by government was noted in our discussions. DDT is permitted in Iran, but the government is asking the companies to move away from the chlorinated hydrcarbon pesticides because of their long residual activity. Pesticides are prohibited from tea and tobacco during the growing season, but the reasons for this were not made clear. Pesticides can be used on citrus but apparently these are restricted to the oils and phosphates.

The extension service recommends all chemicals which have been registered including chemicals to which pests may have developed resistance. Such materials do not lose their registration, but as their market declines the compound may be withdrawn by the seller.

Pesticides are applied using hand-operated knapsack sprayers or motorized knapsack sprayers. Airplanes are used for pesticide application on the larger farm units.

There is little genuine concern about environmental pollution caused by pesticides, or about residue problems, because of the generally low levels of pesticides used on agricultural crops. We have the impression that on cotton, many fewer applications are made each season in Iran as compared to Turkey. Yet cotton is the commodity which consumes most of the pesticides in both countries. Plant protection scientists in Iran, outside of the private sector, told us that Iran could actually benefit greatly from an increase in pesticide use.

Public sector plant protection scientists believe that Iran has genuine interest in non-chemical approaches to pest management. At a recent meeting of the Plant Medicine Congress, held every 2 years in Iran for the benefit of all plant protection people, a resolution was passed that integrated control receive priority attention, and that the use of chemical pesticides be diminished.

While there is little evidence that non-chemical pest control is operational on any crop in Iran, there are some indications that

researchers are giving it due consideration in their research efforts. Of the more than 70 projects underway by scientists at the Plant Pests and Diseases Research Institute, there are projects such as "integrated control of pests of apples," "integrated control of citrus pests," "mass production of Cryptolaemus," as well as many projects on biology and ecology of crop pests; such projects far outnumber the number of entomological investigations directed toward chemical control.

There is serious thinking at Karaj College that integrated control could bring about reduction of losses by Senn pest, Eurygaster integriceps. This project involves integration of biological and cultural control. Quite apart from this, government recommendations for Eurygaster control include the use of Dipterex,® which is reportedly a selective insecticide in relation to the scelionid egg parasite of Eurygaster.

E. Weed Science

Compared to plant pathology or entomology, the study of weed control is limited in Iran. Our visits revealed that herbicides are used to a limited extent in rice and cotton in northern Iran and 2,4-D is used on wheat.

The major use of herbicides appears to be in the Khuzestan region of southern Iran. The Haft-Tappeh sugarcane plantation uses 5kg/ha of atrazine and follows with spot treatments of 2,4-D + dalapon. The research on new herbicides and herbicide combinations is comparable to weed control research in other cane areas of the world. The project is adequately equipped and staffed. Two of the 3 Agro-Industry firms were contacted and they recognize weeds as a major problem. The control methods available to them are inadequate. The firms employ hand labor for weeding and other purposes. The question of the displacement of this labor by herbicides was discussed and found to be a sensitive issue. The firms are emphatic in their belief that herbicide use will be essential to their continued progress. They recognize the problems this could create but state that the labor supply is presently inadequate and will become more so as their operations grow. No other statements were obtained from other sectors on this problem but we sense the inevitability of the shift and the recognition of it by all sectors.

The Safiabad field research station is not adequately staffed to answer the difficult questions exemplified by the Agro-Industry operations. A Development and Resources Company (D&R) consultant in Weed Science is on the staff and he works with one Iranian with a locally-obtained M.S. in weed science. Field help is available. As the D&R role is phased out the present staff is too small and not well enough trained to conduct the required research. D&R recognizes this and is actively working to rectify the situation.

The weed problem can be divided into weeds in crops and aquatic weeds. Dr. D. P. Gowing, a consultant from Hawaiian Agronomics to the

Haft-Tappeh project, and his staff have recently published a book entitled "Weeds and Weed Control at the Haft-Tappeh Cane Sugar Project." The book includes 74 species from 31 families. These represent problems in sugarcane culture and include the major weeds of the area. The Safiabad agricultural research center has prepared a more abbreviated list of the principal weed problems of the Dez irrigation project area. These reports are in Persian and English. Dr. F. L. Timmons (consultant in weed control) prepared in June 1971 a "Survey and evaluation of aquatic and bank weed problems, recommendations on control, testing and demonstration." The weed problems and appropriate solutions are outlined in his paper. His report and our contacts emphasize the present and greater impending problem of aquatic weeds in the Dez irrigation system. No research work is presently under way, contrary to Dr. Rimmons' recommendations. A partial translation of G. Klingman's test, "Weed Control as a Science," is available in Persian.

Principal Weed Problems of the Khuzestan Area of Iran

Scientific name	Common name	Crop(s)[1]	Control rating[2]
Avena leudoviciana and fatua	Wild oat	1,10	2
Chenopodium sp.	Lambsquarters or goosefoot	8,10	3
Cirsium sp.	Thistle	1,8	
Convolvulus arvensis L.	Field bindweed	1,2,3,8,11	1
Cynodon dactylon (L.) Pers	Bermuda grass	1,2,4,10	1
Cyperus rotundus L.	Purple nutsedge	2,3,4,6,7, 9,10	1
Echinochloa colonum (L.) Link	Junglerice	7	2
Erigeron sp.	Mare's tail	11	
Imperata cylindrica (L.) Beauv	Cogon grass	2,3,5,10	1
Panicum Repens L.	Torpedo grass	5	
Phragmites communis Trin.	Bamboo grass	9	1
Portulaca oleracea L.	Purslane	1,2,10	2
Sonchus sp.	Sow thistle	1,8,10	2
Sorghum halepense (L.) Pers	Johnson grass	2,3,4,6,9,10	1

[1] Crops indicated by key number

1. Cereals
2. Citrus orchards
3. Corn
4. Cotton
5. Ditch banks
6. Milo, sorghum
7. Rice
8. Sugar beets
9. Sugarcane
10. Vegetables
11. Vineyards

[2]

1. Serious problem - no good solutions available
2. Serious problem - some control possible with present technology
3. Serious problem - good solutions available

F. Nematology

A nematologist is stationed at each of 3 locations in Iran: Plant Protection Department, Ministry of Agriculture, Evin; Karaj College, Tehran; and Pahlavi University, Shiraz. Each received a Ph.D. in nematology outside of Iran.

The nematology facilities at Evin are located in a new building and consist of 2 extraction rooms, a laboratory for microscopic and similar work, and an office. The laboratories are equipped with the most modern equipment and 3 assistants are on the staff. A relatively small greenhouse was in use at the time of this visit. A branch laboratory is located in an important agricultural area near the Caspian Sea.

Research in nematology at Evin includes investigations on: 1) sugarbeet nematodes, 2) kenaf nematodes, 3) tobacco nematodes, 4) citrus nematodes, 5) pistachio root nematodes, and 6) pulse and cash-crop nematodes. Dr. Dieter Stirhan from West Germany recently conducted a detailed survey of the plant-parasitic nematodes occurring in the northern part of Iran.

Nematology is in the Entomology Section of the Department of Plant Medicine, which is the largest department in the Karaj College of Agriculture. Teaching facilities, including large well-equipped laboratories, are very good. Particularly noteworthy was the large number of excellent German-made microscopes. In the research program there the nematologist intends to determine the kinds of nematodes associated with crop plants in the northern part of Iran. No research on control or pathogenicity is planned for the near future.

At Karaj College the view was expressed that an M.S. or Ph.D. program with specialization in nematology should not be started until there are at least 10 hours of instruction in nematology. There is a medical nematologist located at the University of Tehran, but because of the distance between the campuses, it would be difficult or impossible for a workable cooperative arrangement to be developed between him and the Karaj nematologist.

The teaching facilities for nematology at Pahlavi University, including large attractive laboratories with high quality microscopes and other modern equipment, are exceptional. Research facilities are quite adequate. There is not now an M.S. program in nematology but one probably will be initiated in the near future. The nematologist at Pahlavi University teaches a course in general nematology and conducts research in areas involving relationships between nematode numbers and crop yield, chemical control in the field and greenhouse, laboratory testing of antihelminthitic compounds for resistance to Ditylenchus dipsaci and testing alfalfa selections and varieties for resistance to D. dipsaci. Cooperation between the nematologist and plant breeders is not close.

A few of the important nematode problems in Iran are recognized. These include Tylenchulus semipenetrans on citrus, Meloidogyne spp. on a number of vegetables and other crops, Anguina tritici on wheat,

Ditylenchus dipsaci on alfalfa, and Pratylenchus spp. on vegetables. The presence of these nematode diseases can be readily diagnosed by characteristic symptoms or signs; nematode problems without evident diagnostic symptoms have yet to be recognized. Several plant protectionists stated that as soon as land is irrigated, severe root rot problems often appear rapidly. Based on the world literature these problems are caused by interactions of different kinds of organisms, including fungi, bacteria and nematodes.

There appears to be considerable potential for increasing research and teaching of nematology at Karaj and Pahlavi and research at Evin. At least 1 additional staff member at each institution would be needed. To balance the teaching and research program at Karaj a specialist in nematode control and bionomics might be selected while at Pahlavi a specialist in the general area of taxonomy and morphology would be most suitable. An additional nematologist at Evin would make it possible to accelerate recognition, evaluation, and solution of nematode problems.

G. Plant Pathology

Research on plant diseases is done at government research stations and at agricultural colleges by approximately 75 Iranian plant pathologists. Plant pathologists were visited at Pahlavi University and Karaj College, and at the Plant Pests and Diseases Research Institute at Evin. Considerable effort is made to know and understand the diseases present.

Some of the important crops and diseases are: wheat, stem, leaf and yellow rusts, bunt, loose smut, flag smut, septoria, powdery mildew, and nematodes; rice, blast; cotton, root rots and verticillium wilt; citrus, virus diseases; pistachio, root rot and stigmatomycosis; sugarbeet, viruses; tobacco, tobacco mosaic virus, stolbur and tobacco ring spot; sunflower, downy mildew, Sclerotinia sp. and root rot; soybean, downy mildew and virus diseases. In addition nutritional disorders are a major problem on all crops. Zn, Cu, Fe and Bo are the elements most likely to be deficient.

Not much information was available on the relative importance of different diseases but there seemed to be a good balance of research effort among the diseases caused by fungi and viruses. Soil borne diseases were being carefully studied. Bacteria were not considered important at present because of the dry environment.

The benefits of a well coordinated program in plant pathology are not yet available to Iran. The research centers function independently of the universities and work on applied problems. The universities may do basic or applied research but their programs are based on the needs of the several contracts that provide the money for the research. There is no coordination among research, teaching and extension except that research informs extension of its findings. Rarely does the researcher go into the field with the extension worker.

Education and Training: Good undergraduate training in plant pathology is available at Karaj College and at Pahlavi University. The graduate programs are modeled after the system used in the U.S. The faculty members visited had doctorates from American or European universities, but well qualified laboratory assistants were in short supply.

There seemed to be no important deficiencies in laboratory equipment or supplies. Land was also available for field studies. Library facilities appeared to be adequate, though older literature was often absent.

Research capabilities: Research at the universities has already been discussed. At the research institutes the most comprehensive program is at Evin. Here, applied research is emphasized and the work appeared to be of good quality. Active cooperation with plant breeders for development of resistant varieties was not of high priority. More work should also be done on integrated control.

The plant pathologists at the research institutes are all well educated. All had at least Master's degrees and many hold doctorates from foreign universities. The Institute at Evin had excellent equipment that appeared to be in good repair; the library was adequate. The only complaint the Team heard concerned a shortage of funds to permit frequent travel into the field to pursue research.

H. Entomology

The Team found considerable depth of talent in entomology at the universities and at the national level. At the present level of agriculture, it appears that the numbers of professional entomologists in the country is nearly adequate to handle existing insect problems. At the universities, particularly Pahlavi, additional staffing would lead to much more complete training in entomology. For example, there is at present no insect systematist or toxicologist in the Plant Protection Department there, yet an advanced degree at the M.S. level is being offered.

It is unfortunate that a closer relationship does not exist between entomologists at the universities and those in national service. Talent exists at both of these kinds of institutions which would be mutually beneficial in joint research efforts.

As agriculture grows in Iran, the number of pest problems can be expected to increase correspondingly. As pesticide use increases, this will add another dimension to the plant pest problem. Additional staff will certainly then be needed to keep abreast of these new issues.

Important pests which came to the attention of the Study Team are listed below:

Important Pests in Iran Without Regard to Region

Wheat
- Senn pest

Cotton
- Earias insulana
- Heliothis armigera
- Spider mites
- Thrips
- Aphids

Sugarbeets
- Beet armyworm

Citrus
- Scales
- Spider mites
- Aphids

Other fruits
- Codling moth
- Scales
- Aphids
- Spider mites

Cucurbits
- Aphids
- Thrips
- Cutworms
- Spider mites
- Hylemya sp.

Generally important insects
- Noctuids (Spodoptera, Heliothis, Agrotis)
- Coleoptera (Buprestidae, Cerambycidae)

Important Pests in Khuzestan Province

Cotton
- Earias insulana
- Prodenia litura
- Spider mites

Sugarbeets
- Prodenia litura
- Beet armyworm
- Agrotis sp.

Alfalfa
- Prodenia litura

Sesame
- Leafhoppers
- Armyworm

Cucurbit
- Aphids
- Thrips

Tomato
- Aphids
- Heliothis sp.
- Agrotis sp.

Corn
- Sesamia cretica

Citrus
- Spider mites

Sugarcane
- Sesamia cretica

I. Needs and Recommendations

1. Greater use should be made of university personnel in the development of plant protection strategy and tactics. At present there is limited communication among professional plant protectionists at the universities and at the federal level. Technical information and concepts for making decisions relative to plant protection strategy and

tactics are supplied by staff members at Evin. Procedures should be developed to allow the considerable talent of the Colleges of Agriculture to become involved in making these important decisions.

2. With a trend towards increased numbers of large-scale units of intensified agriculture additional well-trained Iranian plant protection scientists are needed to solve new plant protection problems which will be associated with this type of agriculture. Increased pest and disease problems are almost always associated with intensification of agriculture. An increase in diseases and pests usually results in increased pesticide usage. To solve these new problems more Iranian scientists must be tained in the most modern principles and practices of integrated plant pest control. This necessitates not only an increase in the number of graduates but also curriculum changes.

3. Review of pesticide registration and labelling procedures. There are reliable predictions of significant increases in pesticide use in Iran during the next few years. Pesticide registration and labelling procedures should be reviewed and revised appropriately so that there will be greatest possible protection for growers, other handlers of pesticides, and the general public. These regulations should not prevent importers, formulators and retailers from making a reasonable profit.

4. Shortages of middle-level technicians. In the Karaj and Pahlavi Colleges of Agriculture and the Plant Pests and Diseases Research Institute at Evin, there are very few technicians with a B.S. degree or its equivalent; most of the technicians have only a high school education. If one technician with a B.S. degree could be hired to assist each 2 staff members, and in special situations a technician for each staff member, the teaching and research output could be significantly increased.

AFGHANISTAN

The Study Team visited Afghanistan from September 20-30, 1972. Relatively little traveling was done in the country, for most of the people who deal with plant protection are headquartered in or near Kabul, the capital city. The Team found a low level of development in all aspects of plant protection in Afghanistan. On most crops it may be many years until the more basic factors limiting high yields are overcome, and before operational plant protection can be viewed realistically as a priority area for attention. This state of affairs does not, however, negate the importance of laying some groundwork in plant protection research and teaching.

Afghanistan has a population of about 17 million which is only 5% literate and 10-15% nomadic. More than 75% of the population is engaged in agriculture, much of it subsistence farming. The country is approximately the size of Texas, U.S.A., and has high mountains and arid desert country interspersed by small fertile valleys irrigated by mountain streams. The rainfall never exceeds 15 inches annually. Presently only 15-20% of the land is considered arable. Principal crops include wheat, maize, rice, barley, cotton, and fruits and vegetables.

A. Organization and Functions of Plant Protection Agencies

Plant protection activities at the national level are organized as a specific section under the Agriculture Division of the Ministry Agriculture and Irrigation. The office of President of Plant Protection is now vacant and the organization is under the leadership of a General Director who normally serves as an assistant to the President. There is a Director General in each of the 28 provinces with 5 to 10 people on each staff. There are no village-level workers comparable to those in the crops extension organization.

We were able to determine 5 specific functions of the plant protection department.

1. To evaluate pesticides prior to registration. This evaluation can take the form of an administrative appraisal of existing data in Kabul or efficacy tests conducted under the direction of one or more of the province offices. It is our impression that there is no standard procedure that must be followed.

2. To conduct surveys for major pests such as desert locust.

3. To conduct large-scale control programs. If epidemics of desert locust or Senn pest do occur plant protection has conducted control programs at no cost to the farmer. The last program on Senn pest was conducted in 1962.

4. To demonstrate pest control techniques. We saw no evidence that this was being done.

5. To extend credit, to farmers who do their own spraying, in the event of serious pest or disease outbreaks. In addition to credit the office dispenses recommendations.

Our conversations indicated that the major activity may be problem evaluation (i.e., pest surveys) with little activity in any of the other areas. The plant protection department has no real research responsibility and is involved in research only in a very limited way.

There are no quarantine laws in Afghanistan and no plant protection quarantine effort.

Because of the urgent need for increased wheat production, the entire extension program at the ministry level is concentrated on increasing the use of fertilization and improving other wheat growing practices. When the immediate food crisis eases, an extension program in plant protection should be initiated. Before it is possible to execute such an extension program, adaptive research must be carried out to identify and estimate the damage caused by important pests and diseases and test control procedures. It is important that all agents of loss be given consideration, for essentially nothing has been done to date.

Agricultural missions from a number of countries other than the U.S.A., including Russia, China, France, West Germany, India and Sweden, are functioning in Afghanistan. The PACCA (Program for Agricultural Credit and Cooperatives in Afghanistan) mission financed by the Swedish government and administered through FAO is particularly noteworthy. The objective of this program is to improve the incomes of wheat, grape, cotton and sugarbeet growers by establishing cooperatives and to train farmers and extension workers. In order to obtain new seed and credit a grower must follow practices recommended by the extension workers. Possibly such procedures might be suitable for a future pest management program in Afghanistan.

The Plant Protection Association of Afghanistan was organized during the past year to bring together scientists, technicians, and other interested parties in the field of plant protection. The organization has several objectives: 1) assembly of information on plant protection, 2) provide information on need and uses of plant protection materials, 3) indicate areas for research, 4) identify plant pests, 5) disseminate information on plant pests. The Team attended 1 meeting of the Association at which the members present gave us their views on various plant pest problems and issues. The organization seemed to be useful and should be encouraged to the maximum possible extent.

B. Training and Research Resources and Capabilities

One undergraduate course in entomology and 1 in plant pathology are given in the Faculty of Agriculture of Kabul University. This is

the only faculty of agriculture in Afghanistan, but some thought has been given to starting a second one in Jalalabad at which some of the staff at Kabul University would teach part time.

There is no course offered either in weed science or nematology. Also little or no information on these subjects is presented in other courses. In view of other needs it does not appear likely that a staff member specializing in weed science or one in nematology could be added to the Faculty of Agriculture in the near future. Although not a completely satisfactory solution, enabling several current staff members in related areas to take short courses outside Afghanistan in weed science and nematology would enable them to acquaint students with nematology and weed science. Another possibility would be to send a Ministry of Agriculture employee or trainee to obtain an M.S. degree in weed science and 1 to obtain an M.S. degree in nematology and arrange for these scientists to teach part time at Kabul University. Because there is little or no cooperation between the Ministry of Agriculture and the University it appears unlikely that such an arrangement would be successful under present conditions.

Of the 40 members of the staff of the Faculty of Agriculture 10 have Ph.D. and 25 M.S. degrees, all from outside Afghanistan. Approximately 95% of the faculty received USAID financed graduate training in the U.S.A. The Faculty of Agriculture has the highest percentage of staff members with advanced degrees of any of the faculties in the University. Also as a part of the Kabul University-University of Wyoming cooperative program, assistance in areas such as administration, teaching, research, and purchase and maintenance of equipment to all faculties has been provided by University of Wyoming staff stationed at Kabul.

Despite the well-educated staff, the adequate facilities, and the assistance of the University of Wyoming staff members, the capabilities and resources of Kabul University for research and teaching are quite limited. One of the major limiting factors is the disruptive influence of student unrest. Student strikes against the University or selected faculty members have been frequent and at times have been condoned by the Afghanistan Government. These strikes are so frequent that teaching effectiveness is markedly reduced. Another limiting factor is that the pre-college training of students is extremely poor.

Despite these unfavorable conditions, progress has been made at Kabul University. As was related to us several times, in order to assess progress in Afghanistan the current status must be compared with that several years previous. Apparently there was essentially no Faculty of Agriculture when the Kabul University/University of Wyoming cooperative program was initiated.

A plant protection specialist is not a member of the subject matter advisory committee of the Ministry of Agriculture. There is only very limited research in plant protection being conducted at the laboratories and research farms of the Ministry of Agriculture. Chief activities are

demonstrations to attempt to convince growers of the benefits to be derived from improved practices. This Study Team agrees that at present such activities are more important than research but that when feasible some adaptive research should be initiated.

Funds are needed to equip laboratories and begin research in virus pathology, nematology, and weed science. Afghan students should be sent to another country to obtain at least M.S. degrees in nematology, weed science, and virology. Professional help from abroad is needed to establish and assist in the operation of laboratories in these and other areas of plant protection. The program at these laboratories should emphasize the identification of important weeds, insects and diseases, make estimates of the crop damage each causes, and select and evaluate practical control measures from among those developed in other countries.

C. Pesticides

There are 4 private sector pesticide firms operating at present in Afghanistan. Several of these handle only the products of the foreign parent firms while others carry materials made available from a number of foreign companies. All pesticides are manufactured and formulated abroad because these capabilities do not exist in Afghanistan.

The official policy of government is to support the private firms selling pesticides, in the knowledge that pesticides are necessary for high agricultural productivity, and that Afghanistan represents a difficult market for these products because of a low level of familiarity with agricultural chemicals by farmers there, poor road network, making distribution difficult, etc. Pesticides approved for use in Afghanistan, as well as application equipment, are therefore allowed entry free of duty.

The registration procedure appears to be a haphazard process. Basically, it consists of obtaining written permission from the Plant Protection Department to import a specific chemical. Samples are submitted to the Plant Protection Department by the prospective seller, as are data provided by the parent manufacturer on pests controlled, dosage, etc. Field tests may or may not be run by the Plant Protection Department; if conducted they consist simple of demonstrations, not replicated experiments comparing one product against others. There is no established procedure for testing chemicals. In most cases the label of the parent manufacturer is accepted without question.

Because the registration process is not formalized the procedure changes with the many shifts in personnel which have occurred within the Ministry of Agriculture. Some firms have been importing certain pesticides for years without formal registration.

We were informed that a highly toxic material may in the future be denied entry into Afghanistan. Folidol® (methyl parathion) and Azodrin® are among the more toxic materials now available in the country. We could determine no interest in restricting the use of DDT or other persistent

pesticides. There is no residue testing capability in Afghanistan. Adulteration of pesticides is possible after entry but so far has not been a serious problem because most pesticides are sold in consumer-sized containers. Government does not control the retail price of pesticides.

Private sector sales of pesticides in 1971 were estimated to be 4 tons. This was not the total amount of pesticides used in Afghanistan in that year, however, for government brought in many times this amount for demonstration purposes. Russia provides 150-200 tons of BHC for locust and grasshopper control each year. Crops receiving most of the pesticides are grapes (fungicides) and tree fruit (insecticides). Herbicides are used in only minimal quantity.

The Team received the impression that no profits are yet being realized by the private sector as a result of selling pesticides in Afghanistan. While government is said to openly encourage the private sector's pesticides activity, government may in fact serve as a deterrent to commercial interest because of the haphazard registration procedure. One firm believes that government should restrict the number of firms which operate in Afghanistan in order to permit profit-making by those few permitted to sell there.

Just as there is little organized effort to control pests by chemical means, little effort is being made to control pests by nonchemical approaches. Fortunately there are areas of Afghanistan where certain important insect pests do not occur and every effort should be made to restrict chemical insecticides in the agriculture of those districts in order to prevent possible disruption of the ecosystem, and also from the standpoint of production costs. In this connection, a study of the cotton ecosystem in Baghlan Province was conducted by several Russian workers some years ago. Their conclusions, reportedly, were that a wealth of natural enemies of cotton insects occurred in that area, and pesticides should not be used. This could not be confirmed by a visit to cotton fields in that area, however, but this matter deserves closer attention. Yet the Study Team could detect no indications of real interest in this and other similar situations.

One reason that has been cited for the absence, or low level, of important pests in some areas is the high level of phytosanitation carried out by farmers. It was pointed out to the Team that every plant in Afghanistan has some value. Weeds have value as forage crops; those with woody stems are widely used as fuel. Crop residues are also valued as animal feed, bedding, and fuel. Certainly phytosanitation results in destruction of overwintering sites and substrates of pests and plant diseases. However, there were no indications that phytosanitation was purposefully carried out for alleviation of pest problems.

Very little work is in progress on the development of crop varieties resistant to pests or diseases. What work is being done is limited to wheat, potatoes, and maize, and consists of selecting out possibly resistant material from among introduced varieties and selections.

D. Weed Science

There is no program of weed research in Afghanistan. No herbicides are commercially available, but 2 companies have imported small amounts for demonstration purposes. There is no course in weed science, nor is it included in any other course at Kabul University. No one at the University or in the Ministry of Agriculture has received specific training in weed science. The Agronomy Department at the University has started a weed herbarium but little identification has been done because of the lack of taxonomic assistance.

Visits to the Kabul, Jalalabad, Kandahar, and Lashkar-gah areas revealed serious weed infestations in all crops. As yields rise and the inputs of fertilizer, improved varieties, water management, etc., are made, weeds and other pests will become more important factors in yield reduction. Afghanistan, through the Ministry of Agriculture and Kabul University, should recognize the problem of weeds and begin now to plan appropriate solutions. A survey of major weed problems, by crop, and expansion of the weed herbarium should be accomplished in the near future. Demonstration studies of the effect of weed competition on yields would help to pave the way for the introduction of weed control by hand or cultural methods. Chemical control should be introduced slowly, particularly in crops such as wheat, that are difficult to weed by hand.

The weed control problem is complicated by the fact that all weeds are by-products of agriculture and are not regarded as deterrents to yield. Weeds are viewed as either livestock feed or fuel. Even camelthorn (Alhagi camelorum Fisch), a most unpalatable plant by most standards, is eaten by camels. Thus, an intensive extension effort is needed to convince the farmer that crops are more valuable feed than weeds, that higher yields can be produced with lower weed populations, and even that fuel could be purchased with income from the sale of higher yields.

The programs recommended will first require that those in positions of authority at the Ministry of Agriculture and the University recognize the problem of weeds and commit themselves to work toward solving it. Secondly, people must be trained in weed research and basic agricultural extension to do the adaptive research and education that will be required.

E. Nematology

Only 2 scientists in Afghanistan have had any training in nematology. One is an entomologist, with some nematology training in Germany, who presently is an administrator. The other person received 3 months of training in nematology in India and is the only person currently working in this area. Unfortunately, because his duties also include activities in entomology and plant pathology, only a fraction of his time is spent in nematology.

In Afghanistan essentially nothing is known either about nematodes associated with crop plants or crop damage caused by nematodes. During

the past few months a limited nematode survey was conducted by collecting soil samples in the vicinity of Kabul, extracted nematodes from the soil, and identified nematodes to genus. However, none of the samples was collected from around the roots of a crop plant. Research workers and others indicated that they thought nematodes were causing considerable damage to crop plants; however, there is little evidence to support this belief. Root-knot nematodes have been observed on sugar beets but cyst nematodes have not. FAO Publication 1817 states that the wheat-gall nematode, Anguina tritici, was observed damaging wheat in one province in Afghanistan. Fan leaf of grape is said to be present in Afghanistan, thus the vector Xiphinena index should be present, but no one is certain of this. No other information on nematodes attacking crop plants was noted.

The only nematology laboratory seen was very poorly equipped. For example, only 2 Baerman funnels were available for extracting nematodes from soil or plant parts. Although the compound microscope was adequate, the stereoscopic microscope was extremely poor and there were no microscope lights. A set of sieves and a few miscellaneous pieces of glassware were the only other items in the laboratory. For reference material only 2 or 3 pmphlets obtained while taking the short course in India were available.

In Afghanistan there is an urgent need to determine the nematodes associated with crop plants and to conduct routine field and greenhouse tests to evaluate losses caused by selected nematodes. Funds are needed to equip a nematology laboratory and provide assistance in initiating a nematode survey and a series of diagnostic tests. One, and preferably 2 persons, should be trained in general plant protection with specialization in nematology. One of several universities in a country such as Iran or Turkey would be suitable for such training.

No instruction in nematology is offered at Kabul University.

F. Plant Pathology

There are many plant disease problems in Afghanistan but only a few are considered economically important, though there has been no experimental evaluation of losses. Anthracnose of grape is a major problem and considerable effort is made to control it with fungicides in the PACCA project area. We were told that rusts may ruin wheat crops and that in many fields bunt reduces wheat yields 40% or more.

Plant diseases are generally considered unimportant because the climate is dry and relatively cool during the growing season. The possibility that diseases are more important than is realized is suggested by the fact that many diseases have been identified in Afghanistan but they have been the more obvious ones. Brief observations by the Study Team indicated that virus diseases are common on melons, beans, tomatoes, potatoes and fruit trees, suggesting that viruses are more important pathogens than is realized. Observations also suggested that

root rots are probably taking a larger toll than is realized. There is a need to better identify the important crop diseases and to estimate losses.

While disease is more important than is generally realized in Afghanistan, it is probably correct to agree with persons working in the country that water management and lack of fertilizers are more important problems. Once these major problems are corrected, however, diseases and other pests will rapidly be recognized as limiting factors.

Some efforts in plant disease control are now underway. Wheat varieties are evaluated for rust resistance. Grapes are sprayed in some areas for anthracnose control. An Indian agricultural assistance project hopes to produce virus-free seed-potatoes in a few years. Throughout the country much plant material is harvested for fuel or feed which undoubtedly reduces innoculum sources but this effort is not a conscious disease control measure.

So far as could be determined no adaptive or basic research in plant pathology is being done in Afghanistan by Afghans. Plant pathology is taught at Kabul University as part of the program in agriculture. No specialized training is given, however, and no graduate work is offered. Increased support must be given to the program at Kabul University so that educated plant protection officers and qualified plant pathologists are prepared for careers in agriculture.

The PACCA project provides some training in applied plant pathology as a part of its pest control program. This project trains extension workers, as well as other persons, in the basics of plant pest control utilizing classroom work and field experiences. Graduates of the classes will also receive supervision as they in turn work with farmers cooperating with the project.

There are 4 plant pathologists in Afghanistan. Two Afghanistan citizens are abroad for graduate work in plant pathology in American institutions. In addition, there are 2 Indian plant pathologists working in Afghanistan. The work of the few pathologists in the country needs to be coordinated to insure agreement about what each person shall do and to keep everyone informed. Adaptive research, especially on integrated control, is needed and facilities are needed to carry out this research.

Major Plant Diseases Reported in Afghanistan

Grape
- Anthracnose
- Crown gall
- Physiological disorders
- Powdery mildew

Peach
- Leaf curl

Maize
- Stalk rot
- Smut

Rice
- Brown spot
- Blast

Major Plant Diseases Reported in Afghanistan (cont'd)

Plum
- Powdery mildew
- Brown rot

Apple
- Scab
- Powdery mildew

Melon and cucurbits
- Powdery mildew
- Root rots

Citrus
- Bacterial canker

Wheat
- Stem, leaf, strip rusts
- Bunt
- Septoria
- Loose smut

Sugar beet
- Cercospora leaf spots
- Dodder

Alfalfa
- Dodder
- Common leaf spot
- Rust

Potato
- Viruses
- Early blight

Cotton
- Rhizoctonia and Fusarium

G. Entomology

Substantial variation in the intensity of pest attack occurs in the different agricultural areas of Afghanistan. For example, in the provinces north of the Hindu Kush, aphids, thrips and mites were reported to be the major cotton pests while in the Helmand Valley Earias insulana, E. fabia, in addition to aphids, thrips and mites were said to be the important pests. The pink bollworm is a pest of cotton only in the Jalalabad area.

Rice has no consistently important insect enemies, even where it is grown close to the Pakistan border. Pakistan has several serious stem borer pests of rice but these occur at only very low levels in the Jalalabad region of Afghanistan. Sugar beets are remarkably free of some of the serious pests of this crop which occur in countries to the west. Grapes likewise have no serious insect pests.

It is fortunate that parts of Afghanistan enjoy freedom from many pests, for numbers of trained entomologists at both the University and in the federal plant protection service are very few. This is not to imply that all of Afghanistan's crops are pest free, for some are seriously affected and heavy losses occur every year. Examples are tree fruit and cotton in some areas. Afghanistan needs many more entomologists both to confront present day problems and to seek a greater understanding of the relationships which exist among insects in the hope that this might lead to preservation of the status quo in areas where pests are not now an important limiting factor in crop production.

The following is a list of insect and other pests which consistently were reported as at least occasionally serious on Afghanistan's more important crops:

Cotton
- Aphids
- Thrips
- Spider mites
- Heliothis armigera
- Prodenia sp.
- Earias insulana, spiny bollworm
- E. fabia, spotted bollworm
- Agrotis ipsilon

Tree fruit and nuts
- Hyponomeuta padellus, lesser ermine moth
- Codling moth
- Aphids
- Armored scales
- Almond moth
- Spider mites

Citrus
- Diaphorina citri, citrus psylla
- Phyllocnistis citrella, citrus leafminer

Wheat
- Eurygaster sp., Senn pest
- Aelia sp.
- Zabrus sp.
- Pseudaletia unipunctata
- Thrips

Maize
- Chilo sp.
- Aphids

Sugar beets
- Agrotis ipsilon

Potatoes
- Leafhoppers
- Beet armyworm

General pests
- Locusts
- Grasshoppers

Grains in field
- Birds: sparrows, crows
- Rats, mice

H. Needs and Recommendations

Afghanistan presently is at such a low level of development in plant protection that needs are extensive. Below are listed a few of the more urgent needs, not necessarily in order of importance or priority.

1. Improvement of educational capabilities. It is clear that students reaching the university level have had a very poor elementary education. Without an adequate education in the basic sciences, mathematics, etc. there is little hope that a meaningful B.S., M.S., or Ph.D. can be achieved. Lengthy student strikes, at both the high school and university level, against the administration and even individual teachers or professors, is an unfortunate state of affairs for such a poor and underdeveloped country. Government must find ways of circumventing such educationally-crippling strikes and vastly improve the elementary education capabilities in order to prepare students for university and graduate degrees.

2. Training of middle-level technicians. To improve and increase the output in extension activities and in applied research in plant protection, a large cadre of B.S. (and possibly M.S.) holders trained in the plant protection sciences, is needed. This could be provided by an upgraded curriculum in plant protection at Kabul University, or by sending properly motivated persons to appropriate universities in Iran or Turkey.

3. Definition of pest problems in Afghanistan and establishment of priority pest problems based on loss estimates. We found many differences of opinion in Afghanistan as to the order of importance of pest problems in the country. Estimates of loss caused by the various pests are not available. With presently limited resources, such information is vital in order to launch a systematic attack on the pest problems of greatest significance.

4. Development of an orderly, well defined procedure for registration and labeling of pesticides. Afghanistan needs pesticides and the nature of her agriculture does not appear to present an attractive market to the pesticide industry. Companies willing or allowed to do business in the country must know the route to successful registration. Highly toxic pesticides should be restricted by government. Companies must be allowed to realize a profit from sales of pesticides. The team suggests that registration procedures used in Turkey be used as a guide in Afghanistan.

5. Preparation and enforcement of plant quarantine laws. Such laws do not now exist in Afghanistan, yet a number of important agricultural areas and crops in the country are remarkably free from some serious pests. To protect this position, such quarantine laws, and enforcement of them, is essential.

6. Coordination of all existing plant protection agency activity with other agricultural production agencies. With limited resources, both financial and human, far more effective research and extension activities are possible. Afghanistan can ill afford to continue to have these agencies function out of contact with one another.

7. Introduction to weed science and nematology in the university plant protection curriculum. No plant protection curriculum can afford to ignore the potential or actual losses to agriculture caused by these agents. At present, no coursework is available at Kabul University in these disciplines. Steps should be taken to offer such courses in the future.

PAKISTAN

The Study Team traveled in Pakistan from September 30 to October 11, 1972, and visited the institutions and agencies listed at the end of this report. Most visits were made in the Punjab, relatively few in the North-west Frontier Province and Sind, and none in Baluchistan.

Pakistan has a larger population (approximately 60 million) than any of the other 3 countries visited and has a land mass roughly equivalent to the combined areas of Texas and Oklahoma, U.S.A. The Indus River Valley, with its approximately 25 million acres of irrigated land, provides much of the country with an extremely fertile agricultural area. Much of this land is cropped twice each year. Wheat is the staple crop; other important crops in the country include rice, cotton, sugarcane, pulses, maize, oil-seeds, tobacco, and tropical, subtropical, and temperate fruits. About 80% of the population is engaged in agriculture and exports of cotton and rice account for the majority of foreign exchange earnings.

The Team experienced great difficulty in attempting to reach an understanding of the complex institutional structures in Pakistan. A high degree of decentralization of activity in plant protection and other areas of agriculture exists, for the 4 provinces function essentially as independent, autonomous states. In addition, the central government carries on plant protection and related agricultural activities.

A. Organization and Functions of Plant Protection Agencies

Plant protection is organized and functions at the central and provincial levels of government. The Department of Plant Protection is the technical arm of plant protection at the central government level and has 5 primary functions: aerial spraying, locust control, plant quarantine, research (including maintenance of an insect museum) and the coordination of all plant protection activities. It also registers pesticides for use in central government plant protection activities after appropriate field tests. Central government pesticide registration does not have any bearing on the similar process conducted by each province. We understand that a new pesticide ordinance has been promulgated but not implemented and that under it the central government will assume a dominant role in registration.

Central government research on aerial spraying and locust control is headquartered in Karachi and that on wheat diseases at Rawalpindi. Some central government plant protection research is also conducted at the Cotton Research Institute at Multan.

The Team was unable to gather a comprehensive picture of plant quarantine activities in Pakistan. National laws and regulations enacted in 1914 and reaffirmed in 1949 provide for legal control of plant pest movements. Most of the activity involves regulation of international traffic in plants and plant products. Major emphasis is on the prevention of

entry of cotton boll weevil, Colorado potato beetle, woolly aphis, raisin moth, Mediterranean fruit fly, citrus scales, Japanese beetle and golden nematode. A new law has been formulated by central plant protection but is not yet in effect.

Internal plant quarantine laws are administered by the 4 provinces. There is, for example, one that requires destruction of rice stubble after harvest and another that sets the earliest date for sowing rice nurseries; both of these are directed toward control of rice stem borers. We were told that there is hesitancy on the part of some officials to institute and enforce internal quarantine measures.

The plant protection activities of the central government seemed relatively weak compared to those of the provincial governments, particularly the Punjab. Central government work seemed fragmented and out of the mainstream of plant protection. In the provinces the Team was assured several times that the central government exercised little or no control over provincial activities. However, central plant protection considers coordination and definition of national, rather than regional, goals to be its major role and is attempting to pursue it vigorously.

Plant protection activities in the provinces are organized under the Secretary of Agriculture of each province and are usually further subsumed under the provincial agricultural research institute and the extension service. The agricultural research institute, commodity research stations, universities or colleges, and the extension service form the plant protection organization in the provinces, although all these agencies do not exist in all provinces. Each of these agencies is officially independent but their work is often coordinated by official actions and to some extent by individual relationships. In Baluchistan, the Sind, and Northwest Frontier Provinces plant protection is carried out by the extension service and the agricultural research institutes.

The Punjab has the most elaborate provincial organization. Most research scientists are in or attached to the Punjab Agricultural Research Institute at Lyallpur. A plant protection institute was established at Lyallpur about 1 year ago and it reportedly may assume some research activities in the future; no other province has a similar institute. The Plant Protection Institute's primary functions are to:

1. Organize and carry out pesticide registration in the province.
2. Administer provincial plant quarantine.
3. Establish a pest forecasting service.
4. Instruct and train extension workers in plant protection techniques.
5. Monitor pesticide residues in crops and soil.

Because the Institute is still young, none of these functions are yet carried out fully and some not at all. While there is a genuine need for such an agency to perform the above duties, the Team believes that it should function on an all-Pakistan basis for maximum effectiveness.

Why not, for example, instruct extension workers -- or at least extension training leaders -- at 1 location with the best personnel available? Since pests and pathogens do not recognize provincial borders, why not develop pest forecasting networks on a commodity basis for all of Pakistan? Also, the pesticide registration process need not be carried out separately in each province. And finally, the monitoring of residues requires rather highly sophisticated equipment and training; the Study Team does not believe that a country with only limited resources should attempt to duplicate such services and capability in each province, yet the services clearly are needed in each province.

Although research in plant protection is not now done at the Plant Protection Institute, interest was expressed in developing a research effort there. The Team believes that the Plant Protection Institute should retain service to agriculture as its sole function and it should not embark on a course of plant protection research. Those engaged in plant protection research can be of much greater value as part of an overall program in agricultural research. Fragmentation of program areas along subject matter lines does not permit adequate interaction among scientists. For example, plant pathologists should be as closely involved with plant breeders as with entomologists. To transfer plant protection research workers from the Punjab Agricultural Research Institute to the Plant Protection Institute would, in our opinion, be counterproductive.

The Punjab Agricultural Research Institute is considerably larger than similar provincial institutes in the Northwest Frontier Province at Tarnab, and the Sind at Tandojam. It consists of 25 research sections, or laboratories, 17 of which are located at Lyallpur and 8 elsewhere in the Punjab. Plant protection research is an important component of the overall program at the Institute.

Important plant protection activities are carried out at the agricultural universities and colleges in Pakistan. By far the largest and best of these institutions is West Pakistan Agricultural University (WPAU) at Lyallpur. Unfortunately, the Study Team had no opportunity to visit the agricultural education institutions in other provinces. At WPAU teaching and research are said to be given approximately equal emphasis although in reality teaching is given top priority. This institution also becomes involved in some planning and modeling for extension activities. It appeared to the Team that WPAU was not involved to any extent in national or provincial plant protection policy as it affects research or action policy decisions. Although close liaison exists between WPAU and the provincial institutes at Lyallpur, plant protection policy apparently is set by government. Much more input into Pakistan's plant protection policies and programs at both the provincial and federal levels should be provided by technical persons at all institutions having plant protection responsibilities.

B. Training and Research Resources and Capabilities

Provincial faculties of agriculture at located at Lyallpur, Peshawar, and Tandojam, and a fourth will be located at Quetta. Of the 3 presently

in existence the faculty at West Pakistan Agricultural University, Lyallpur, is the most important in the training of plant protection workers. There the teaching departments are: Soil Science, Agronomy, Plant Pathology, Entomology, Horticulture, Plant Breeding and Farm Forestry. As an indication of the rapid development of the Faculty of Agriculture, there was only 1 staff member with a Ph.D. in 1962 but now there are approximately 100. The USAID-funded Washington State University contract contributed greatly to this rapid improvement. The B.Sc. and M.Sc. degrees are offered in plant protection; in plant pathology and entomology a student may register for either one or these degrees as well as for the Ph.D. One course in nematology and 1 in weed science are given in the Department of Plant Pathology. A graduate student may major in plant pathology and do his thesis research in nematology.

A considerable number of undergraduate and graduate students are being trained in plant protection at WPAU. For example, 300 students at present take plant pathology and entomology during their junior year. There are good indications that these students are receiving sound training. A wide variety of courses are offered both in entomology and plant pathology. Many of the teachers have Ph.D. degrees. The use of external examiners and the requirement of thesis approval by external examiners are major attempts to maintain high tandards. Graduate students may do all or part of their thesis research at the nearby agricultural research institute, thus making it possible for these students to profit from the additional equipment, experience, and talent of the research institute staff.

A number of new buildings for the Faculty of Agriculture have recently been completed and several additional ones are under construction. When these are completed the physical plant will be a modern and adequate teaching and research unit. The library is one of the best we observed in the 4 countries visited; there is, however, a shortage of textbooks. Recently the government has been reprinting these at a fraction of the cost of original copies. If, as is predicted, the language used in teaching is changed from English to Urdu, the textbook shortage will be greatly aggravated. Translating texts from other languages into Urdu, or writing new ones in Urdu, will be a time-consuming and difficult procedur Teaching in Urdu also is likely to make it more difficult to instruct foreign students, of which there are 50 at the present time, and cause WPAU to lose its international status. All these arguments, of course, would have to be weighed against the very real possibility that extension activities might be improved if greater emphasis on Urdu was given during the educational program of future agricultural officers, for many Pakistani farmers are not fluent in English.

It was mentioned to the Team that because of a shortage of foreign exchange and the lengthy procedures involved in gaining approval for and placing orders, glassware, laboratory chemicals, and spare parts for laboratory equipment are in short supply. This problem was not unique to WPAU, for at several institutions the Study Team was requested to use its influence to encourage USAID to provide help in a multitude of small ways.

In many cases it appeared that the bureaucracy of government served as a formidable impediment to progress in agricultural research and teaching. To those in need of assistance, it seemed much easier to seek the aid of an outside agency rather than attempt to work through official governmental channels.

Apparently the relatively low salaries for staff members adversely influence morale and increase the likelihood of losing good staff. Because of higher pay, teachers and research workers are frequently lost to administration or join the private sector.

Although WPAU is a provincial institution, students from the other provinces are permitted to receive their education there. The Study Team hopes that this arrangement continues, and that WPAU goes much further toward developing into a center of excellence for all of Pakistan and possibly beyond. With limited financial resources, it is unlikely that Pakistan can afford to develop 4 provincial institutions of the magnitude and quality of WPAU in the near future.

The Study Team visited provincial agricultural research institutes at Lyallpur (Punjab Province) and Tarnab (Northwest Frontier Province) and the Cotton Research Institute at Multan. The institute at Lyallpur is the largest of the 3, having 31 senior research officers, 109 junior research officers, and 260 research assistants. There are 8 substations, or outside programs, of the Lyallpur institute and 4 of the Tarnab institute These 3 institutes all have plant protection research as a part of their programs.

Although there was considerable research in progress on plant pest control by chemicals, other research, including testing crop varieties for resistance to pests and diseases, was being conducted. There appeared to be little activity on control by cultural practices or on integrated control. At all institutes there is a need for research aimed at assessing crop losses caused by insects, plant diseases, nematodes and weeds. Although time-consuming, such research is relatively inexpensive and the results would be of great importance as the first step in developing pest management programs.

C Pesticides

Until recently, all pesticides used in Pakistan were imported, distributed and applied to crops without cost to farmers. The only private sector involvement in pesticides was the manufacture of technical DDT and BHC. This picture has changed somewhat with the decrease of the 100% subsidy (in the Punjab) first to 75% and now to 50%. The subsidy remains at 75% in the Northwest Frontier Province and Baluchistan and is 50% in the Sind.

In the Punjab the pesticide situation has changed even further during 1972 with the transfer of pesticide distribution to the private sector. Eleven firms are presently authorized by government to distribute and sell

pesticides; this number is believed by some to be too high for the sales volume expected during the early years of this venture.

Registration (standardization) procedures are the same in all provinces, yet a commercial firm must register its compounds in each of the 4 provinces, and with the central government Plant Protection Department, before sales can be made throughout the country.

In pursuing registration in the Punjab, a commercial firm must first submit samples for field testing by the Punjab Agricultural Research Institute in cooperation with the extension staff and the Plant Protection Institute. Two years of small-scale efficacy tests are conducted before government imports a larger quantity for 1 year of large-scale field trials. The successful candidate pesticides are then added to the approved list after study of data provided by the manufacturing company and due consideration given to toxicity and cost. Field data from provinces other than the registering province are not considered in the registration process. Pesticide labels must be approved by the Agriculture Department and only pests against which field tests have been successful can be listed on the label. The list of standardized pesticides for regular use in the Punjab now includes 38 insecticides, 3 fungicides, 2 herbicides, and no nematicides. Application equipment also must be registered.

The registration process seems unnecessarily tedious. While we subscribe to adequate testing of all pesticides potentially useful in Pakistan agriculture, we see no value in committing valuable research talent to field testing compounds with synonymous active ingredients (but different trade names), as we were advised is required at present. Moreover, data from provinces other than the registering province should be given weight in the registration process, as should good data gathered by agencies other than the Agricultural Research Institute, the Plant Protection Institute, and the extension service. Selectivity of insecticides to insect pests should be given attention in the evaluation, registration, and recommendtion phases of pesticide work.

With the limited resources available in Pakistan, we believe the number of pesticides approved for use in the Punjab alone is too extensive. Valuable foreign exchange is used to import, in some cases, high priced compounds when less expensive materials would accomplish the same end. Similarly, valuable foreign exchange is being spent unnecessarily because of the low capacity for formulating pesticides in Pakistan. Much inert ingredient, in the form of formulated materials, is imported each year. We recommend that formulation capacity be increased in the country.

In connection with a proposed USAID loan to Pakistan for pesticides, we note that nearly 70 compounds have been requested, and that each province has listed its "needs" separately. We do not believe that Pakistan needs all these materials and suggest that in future USAID loan requests, each specific pesticide need be associated with a specific crop and pest. This and other means taken to reduce the number of pesticides available should help to prevent Pakistan's farmers from being overwhelmed by an

unnecessarily wide choice of materials. Finally, we do not believe that the needs for pesticides in the various provinces differ as much as this listing suggests, for many crops and pests are similar among the provinces. A close and coordinated examination of genuine pesticide needs throughout the country is warranted if for no other reason than economy.

We were advised that mammalian toxicity plays an important part in the decision to import, or not to import, a particular compound. Yet, we note that materials such as Phosdrin®, Thimet®, and Gramoxone® are included on the list of approved pesticides and thus, we do not believe that toxicity is given as careful consideration as it should. The vast majority of Pakistan farmers are neither accustomed to nor skilled in the use of highly toxic materials and the hot temperatures under which they must often apply these materials essentially negate the use of rubber gloves and boots, as well as other protective clothing and respirators. The Team urges the abandonment of highly toxic pesticides for any general use regardless of whether the application is made by air or ground.

The Central Plant Protection Department operates several aircraft for locust control and for the spraying of crops at the request of provincial agricultural authorities. In the past this has been done without cost to the grower (except for sugarcane) although consideration is being given to charging for this service in the future. The Team recognizes that aerial spraying is the only practical way of handling a pest outbreak on short notice, yet the diversified agriculture of Pakistan is poorly arranged for proper aerial spraying. Of the 4.2 million acres of cotton grown each year, only about 100,000 acres are considered suitable for spraying because of size of fields and their location in relation to each other. On both small and large-scale farms, a variety of crops is grown and it is not possible to spray only a single crop in this patchwork arrangement without at least partial coverage of waterways, other crops, and in some instances inhabited dwellings. This problem would be partially alleviated if highly toxic pesticides were not available.

It is widely believed in Pakistan that government should have the entire responsibility for the protection of growers' crops from pests. The Team does not share this view and believes that plant protection should be the grower's responsibility except for such activities as pest forecasting, quarantine enforcement, extension, etc. Government spraying of growers' fields is not now successful in Pakistan. It is the larger grower who benefits most from this activity and plant protection must become equally available to the small farmer. Growers must be educated to recognize signs and symptoms of pest damage, become aware of the losses being caused, and be taught means of dealing with pests. This educational work should be an important charge to the extension service.

Critics of this view would argue that it does little good to protect 1 field from pests if neighboring fields are left unprotected, and for this reason government must step in and carry out plant protection itself. For some pests community action is necessary. For others, such as stem borers of rice, individual plantings can be properly protected regardless

of the existence of adjacent unprotected fields. Extension must become organized to deal with community actions when these are necessary, but the growers must be prepared to carry out the actual plant protection themselves. Government cannot possibly mobilize sufficient men, equipment and materials to protect all fields at the time optimum for protection.

Pesticide consumption in Pakistan is not great and it has been estimated that in the case of cotton, only about 15% of the acreage is treated. Estimates for other crops are less than this figure. Of all pesticides, insecticides represent the largest part of the volume used. Cotton, rice, and sugarcane, in that order, are the crops treated most frequently.

In the Punjab, government withholds 25% of the pesticides imported, and the remainder is taken by the private sector. Government distributes and sells its 25% in areas not serviced by the private sector because of the paucity of agriculture in some regions. Some of this material is also used in governmental pest control programs. Government sets the maximum selling price for pesticides and is not permitted to sell its stocks for less than the maximum price which the private sector is allowed to charge. All public sector sales are handled by the extension service. Adulteration of pesticides has been a problem in Pakistan, as has deterioration of pesticides held for uncommonly long periods under poor storage conditions.

Pesticides are commonly imported and distributed in large containers. A small farmer is expected to carry his own container to the distribution point to receive the material. Thus the grower does not have access to the label, which significantly increases the likelihood of both improper use and personal hazard. Pesticides must be packaged in consumer-sized units to avoid these problems.

It was the Team's understanding that if the private sector imports pesticides directly, it loses certain duty advantages. Government, therefore, does the majority of the importing, often on barter arrangements with countries which unfortunately can provide only poor quality pesticides. The private sector, then, is forced to accept what is imported. This situation should be corrected in order to encourage the private sector to sell a quality product and to fix responsibility for product quality in the private sector. However, government probably must retain some control over procurement.

Among the plant protection scientists and other personnel contacted in Pakistan, there appeared to be general recognition of the need to consider means other than chemicals for the solution of at least some pest problems. Economics, rather than environmental pollution, was the basis for their concern.

While little actual work is in progress in Pakistan on integrated control or pest management, considerable thought has been given to such programs both in cotton and rice. Cotton entomologists are fully aware of the fragile nature of the cotton ecosystem. They recognize that cotton

jassids are a key pest problem, and that such pests as Heliothis and spider mites often develop higher populations when chemical control efforts are directed against jassids.

D. Weed Science

Small-scale herbicide testing programs were underway at the 2 provincial agricultural research institutes visited. No good weed control research was found with the exception of the program on rice conducted by CIBA-Geigy Co. As indicated elsewhere in this report, agricultural research is largely the responsibility of the provincial agricultural research institutes and their substations. Their limited herbicide testing programs, which alone do not constitute good weed science programs, and the total lack of trained weed scientists and the requisite equipment explicitly exhibit the very low priority assigned to weed science. Even our very brief survey showed that the weed problems were serious enough and yield losses great enough to justify more research on this problem of plant protection. A partial listing of some of the problems encountered and the potential for solution follows:

Specific Weed Problems in Pakistan

Scientific name	Common name	Crop(s)[1]	Control rating[2]
Brachiaria spp.	Signal grass	6	1
Carthamus oxyacantha Rieh.	Thistle	7	2
Chenopodium album L.	Common lambs-quarters	1,5,6,7	3
Convolvus arvensis L.	Field bindweed	1,2,5,6,7	1
Cuscuta spp.	Dodder	1,2	3
Cynodon dactylon L. Pers.	Bermuda grass	1,2,3,5,6,7	1
Cyperus difformis L.	Smallflower, Umbrellaplant	1,2,3,4	1
Cyperus rotundus L.	Purple nutsedge	1,2,3,4	1
Cyperus spp. (several)	Sedges	1,2,3,4	1
Digitaria timoorensis	Crabgrass	2,3,6	2
Echinochloa colonum L. Link	Junglerice	1,2,4,6	2
Echinochloa crusgalli L. Beauv.	Barnyard grass	1,2,4,6	2
Eclipta alba L. Hassk.	Eclipta	2,3,4	1
Euphorbia prostrata L.	Spurge	2	1
Fumaria parviflora L.	Fumitory	7	2
Heliotropium supinum L.	Heliotrope	1,2,6	3
Paspalum distichium L.	Knotgrass	3,4,6	1
Portulaca oleracea L.	Purslane	1,2,3	3
Solanum nigrum L.	Black nightshade	1,2,3,6	3
Sorghum halepense L. Pers.	Johnson grass	1,2,3,6	1
Sphenoclea zeylanica Gaertn.	Gooseweed	1,4,6,7	1
Striga lutea Lour.	Witch weed	6	2
Tribulus terrestris L.	Puncture vine	1,2,3,6	2

[1]

1. Corn
2. Cotton
3. Orchards
4. Rice
5. Sugar beet
6. Sugarcane
7. Wheat and small grains

[2]

1. Serious problem - no good solutions available
2. Serious problem - some control possible with present technology
3. Serious problem - good solutions available

The weed problem will soon become a more noticeable limiting factor in the production of crops. The present level of research is not adequate to cope with the problem and develop the solutions the future will demand.

E. Nematology

There are very few research, teaching, or extension activities in plant nematology in Pakistan. A laboratory exclusively for nematological activities was not visited; this work was conducted in corners of laboratories used primarily for other activities. (Since returning to the U.S. the Team learned that a nematology laboratory exists at the Pakistan Council of Science and Industrial Research in Karachi.)

The only nematology course taught in Pakistan is offered at WPAU by a faculty member who also teaches 3 courses in plant pathology. Thus far 4 graduate students have done M.S. thesis research on problems involving plant nematodes. Data from 1 of these theses indicated that the presence of root-knot nematodes increased the severity of chick pea wilt and data from another showed that severity of cotton wilt was increased by nematodes.

Only nematode diseases with readily evident symptoms have thus far been recognized. These include: 1) sugar beet cyst nematode (Heterodera schachtii) damage on sugar beets, 2) citrus nematode (Tylenchulus semipenetrans) on citrus, 3) ear cockle of wheat caused by Anguina tritici, and 4) root-knot nematodes (Meloidogyne spp.) on a number of crops, including cotton, tomato, tobacco, okra, potato, and pepper.

Recently the golden nematode, H. rostochiensis, of potatoes and the soybean-cyst nematode were found for the first time in Pakistan. A number of ectoparasitic nematodes, including Xiphinema spp. and Tylenchorhynchus spp. were extracted from soil samples. Very small quantities of nematicides are used commercially in Pakistan at present.

The extremely high temperatures, the types of crops grown, and the cropping systems (including the growing of several crops per year) assure that nematodes and nematodes in association with soil fungi and bacteria are causing considerable damage to crop plants in Pakistan. To quote a Pakistani plant pathologist, "Recently when we started looking we found nematodes everywhere."

It is important that the nematode problems of Pakistan crops be

identified and estimates made of crop losses caused by them. The cost of such an effort would be low. However, to be successful, efficient and effective, but not elaborate, laboratories exclusively for nematology must be set up in several parts of Pakistan. Each laboratory should be staffed by at least 1 well-trained senior nematologist working exclusively on nematode problems. Associated with each should be a glass-house in which reasonable temperature control is possible. One or more practical and experienced foreign nematologists as consultants would be needed to assist in establishing these laboratories, to help in developing models for estimating crop losses caused by the different types of nematodes, and to assist with training.

Only after a nematode problem is identified and it is established that it causes important crop losses should research be conducted to develop control measures. In these studies control measures such as varietal resistance and cultural practices should be considered along with chemical control.

At present in Pakistan top priority in agricultural research should be given to varietal improvement and cultural practices. However, in the near future when these improved practices are accepted and used widely by growers a serious limiting factor to additional yield increases is likely to be root destruction caused by soil organisms such as nematodes, fungi, and bacteria. It is evident that root problems are reducing yields of many crops at the present time. Because field tests are involved it takes several years to identify and estimate losses caused by root problems. Thus, the expenditure of a relatively small sum of money to start such a program without delay is an important need and would be an excellent investment.

F. Plant Pathology

There are about 60 plant pathologists in Pakistan. Ten of these are full time administrators and 13 work on diseases of wheat. The remainder are assigned to work on diseases of other crops; usually 1 man is assigned to a crop. Most of the work is done on diseases caused by fungi but some work is also being done in nematology, mycology, virology and genetics as these subjects relate to plant pathology. The exact level of education of these scientists was not provided the Team but an estimate based on their appointments indicates that about 15 hold the doctorate and about 45 hold the M.S. degree. Most of the doctorates were earned in foreign institutions, mostly the U.S.A., and most of the M.S. degrees were earned in Pakistan.

Thus it appears that Pakistan has a shortage of highly educated plant pathologists. Most of the plant disease activities are carried out by workers holding only the M.S. degree who are usually working alone. The greatest number of people work on wheat but only 2 hold the doctorate. Institutions such as WPAU have the capability to train further these plant pathologists holding lower degrees.

Fortunately, the pathologists working on wheat and rice cooperate with plant breeders. This should be continued and encouraged with every crop where resistance is the most economical method of control. Disease gardens should be established for every crop.

There is a great need to determine experimentally the losses that result from plant disease. Work is being done evaluating chemicals for disease control and varieties for resistance but the economic injury levels of the various diseases are not known.

Education in plant pathology is probably adequate; it is offered to undergraduates in several universities and colleges and the M.S. degree can be earned in faculties of agriculture in the NWFP, Punjab, and Sind. The doctorate is offered only at WPAU. Everything possible should be done to strengthen this institution to insure an adequate supply of plant pathologists.

As indicated, most research is directed toward the diseases caused by fungi. Some is also directed toward potato viruses but none toward bacterial diseases. As more pathologists are trained these 2 areas should receive more attention.

Some Plant Diseases of Pakistan

Wheat (major crop)
- Stem rust, leaf rust (major diseases)
- Yellow rust
- Loose smut (major disease)
- Bunt (in hilly areas)
- Flag smut

Rice (major crop)
- Blast (major disease)
- Kernel smut (major disease)
- Bacterial blight
- Stem rot sclerotium
- Brown leaf spot

Cotton (major crop)
- Angular leaf spot (major disease)
- Fusarium wilt (major disease)
- Rhizoctonia root rot (major disease)

Sugarcane (major crop)
- Mosaic
- Smut

Gram (major crop)
- Blight (major disease)
- Wilt (major disease)

Potatoes
- Viruses
- Early blight

Mango
- Malformation (major disease)

Citrus
- Citrus canker

G. Entomology

Nearly everywhere the term "plant protection" was equated with insect control. It was most difficult to enlarge discussion to include agents other than insects. As in other countries visited, this situation probably is attributable to the greater visibility of insects and insect-caused plant damage.

Limited data are available on losses caused by insect pests in Pakistan: 1/

1) A Basmati 370 rice crop grown at Kala Shah Kaku in 1969 and protected from stem borer attack by application of diazinon granules yielded 41 maunds as compared to 11 maunds in the untreated control.

2) Cotton grown in 1965 at Multan and protected from pink bollworm attack by insecticidal sprays yielded 25 maunds of seed cotton as compared to 12 maunds in the untreated control.

3) Cotton of the variety AC 134 grown at Lyallpur in 1969 yielded 26 maunds when protected by sprays and only 17 maunds when left unprotected. The variety Deltapine, in the same experiment, yielded 24 maunds when protected and only 2 maunds when unprotected.

The above examples do not throw light on the economic injury level of the insects involved, only on the gross yield differences between treated and untreated crops. Nevertheless, they do point up the dramatic losses accruing from insect pests on the crops studied. Much more data of the same kind, in addition to economic injury level data, are needed in Pakistan and other developing countries.

Pakistan has a shortage of trained research entomologists to pursue ecologically-based pest management programs. The Team found little emphasis on such fields as biological control and microbial control; the only biological control activity seen was the work in progress by the Commonwealth Institute of Biological Control at Rawalpindi and preliminary investigations on biological control of cotton pests at the Cotton Research Institute, Multan. Only 1 course in biological control is offered in a university, this at WPAU. Many entomologists would benefit from an opportunity to pursue a higher degree, and many with an advanced degree should be permitted to spend a period of 6 months to 1 year in refresher programs in a developed country.

Below is a listing of insects considered to be "very serious" or "most serious" on various crops in the Punjab.

Sugarcane

Top borer, *Scirpophaga nivella*
Stem borer, *Chilotraea infuscatella*
Gurdaspur borer, *Bissetia steniellus*
White mite, *Schizotetranychus* sp.
Red mite, *Paratetranychus indicus*

1/ Haq, Khawja Abdul. 1970. Losses caused by crop pests in Pakistan. J. Agric. Research (Punjab) 8(3):297-305.

Maize

Stem borer, Chilo partellus
Shoot fly, Atherigona spp.

Rice

Yellow stem borer, Tryporyza incertulas
White stem borer, Tryporyza innotata
Pink stem borer, Sesamia inferens

Cotton

Cotton jassid, Empoasca devastans
Cotton whitefly, Bemisia tabaci
Cotton aphis, Aphis gossypii
Pink bollworm, Pectinophora gossypiella
Spotted bollworms, Earias insulana and E. fabia

Wheat

Wheat jassids, Zygina, Balclutha and Empoasca spp.
Pink stem borer, Sesamia inferens

Oilseeds

Cabbage aphis, Siphocoryne indobrassicae

Gram

Gram cutworm, Agrotis flammatra
Gram pod caterpillar, Heliothis armigera

Tobacco

Tobacco caterpillar, Prodenia litura

Lady's Finger (Okra)

Spotted bollworm, Earias insulana

Brinjal (Egg-plant)

Brinjal fruit borer, Leucinodes orbonalis
Brinjal stem borer, Euzophera perticella

Cucurbits

Fruit fly, Dacus spp.

Potato

Potato tuber moth, Ghorimoschema operculella
Cutworm, Agrotis spp.
Aphid, Myzus persicae

Fruit Crops

Citrus psylla, Diaphorina citri
Citrus whitefly, Dialeurodes citri
Citrus leaf miner, Phyllonistis citrella
Mango mealybug, Drosicha stebbingi
Fruit fly, Dacus spp.
Pomegranate caterpillar, Virachola isocrates

Stored Grain

Khapra beetle, Trogoderma granarium
Brown grain beetle, Rhizopertha dominica
Rice weevil, Sitophilus granaria
Flour beetle, Tribolium castaneum
Angoumois grain moth, Sitotroga cerealella
Pulse beetles, Bruchus chinensis and B. analis

H. Needs and Recommendations

1. Continue to strengthen the university educational system. West Pakistan Agricultural University at Lyallpur is a good educational institution. Many of the agricultural scientists, including the plant protection scientists in Pakistan, have been trained there. While we encourage the development of other existing educational institutions we believe that with Pakistan's limited financial resources it is best to attempt to develop only 1 center of excellence at this time. Despite the stature of WPAU, we found serious weaknesses in its plant protection educational and research programs. Nematology, weed science, and several areas of plant pathology are especially in need of greater emphasis. Attention should also be given to biological control and ecology as these relate to all fields of plant protection.

2. Encourage scientists to remain in teaching, research, and extension chroughout their careers. Qualified scientists too often are given administrative assignments that take them away from teaching, research and extension. They consent to do this at least partly because financial remuneration is better and because the administrator achieves greater recognition and status.

3. Additional training of plant protection workers. Relatively few plant protectionists hold doctorates in their subject matter fields. Many hold masters degrees but are inadequately trained for the work and responsibilities they are assigned and have little opportunity to receive refresher training to keep up with new developments. This should be corrected by encouraging plant protection workers to seek further education in graduate and postgraduate programs, participation in specialized training programs, such as those offered at CIMMYT and IRRI, or by in-service training. Few middle-level technicians are properly trained and extension workers in the field have had insufficient training to allow them to be effective plant protection advisors.

4. Access to Indian plant protection literature. India has large and comprehensive programs in the areas of entomology, plant pathology, nematology, and weed science. Much of the information developed in these programs is published in the Indian journals. We found Pakistan workers to be largely unacquainted with the Indian work because the literature was just not available. Means should be found to make the Indian information available to Pakistan scientists because many of the problems are similar in the 2 countries.

5. Improve and expedite supply and equipment procurement procedures. Inefficient governmental policies for evaluation of requests and eventual procurement of small supplies, (e.g., microscopes or reagent chemicals) inhibit the development of research programs and teaching. These policies also frustrate and may drive away scientists who try to work within the system. It is often far easier to go to USAID or another donor agency to obtain supplies required to start or continue a program. Purchasing regulations are a required part of any research organization but they should be designed to serve the scientist, not hinder him. The example of the radiation research institute at Lyallpur demonstrates that certain institutions do have effective procurement arrangements.

6. Establish a strong central plant protection agency. The existing central plant protection department does not lead the national effort in plant protection; instead, its efforts are fragmented and directed toward just a few of the plant protection problems of Pakistan. The present central government department of plant protection should be strengthened to make it an effective voice for the plant protection needs of Pakistan. The present fragmentation of authority and responsibility among the provinces has fostered a spirit of competition rather than cooperation. The central government plant protection department should redefine its goals to include all aspects of plant protection and assume such responsibilities as plant quarantine, pesticide registration, pest surveys and forecasting, training of extension workers in plant protection techniques, pesticide residue monitoring, maintenance of collections of weeds, nematodes, insects and other pest materials for reference purposes, etc. This should not be a research agency but a service agency with a coordinating role in plant protection research a part of its activities. Such an agency should be located closer to the agricultural heart of Pakistan, such as the federal district in Islamabad, rather than in Karachi where it is located at present. Because of regional differences in pests, damage intensity, etc., several substations will likely be needed.

7. Determine the important plant pest problems and the extent of loss. Only the more obvious problems such as foliage diseases and insects are recognized. Control measures for these problems were being studied and often carried out. Soil-borne problems, virus diseases and weeds were largely ignored. Systematic surveys should be made on the major crops to determine the most frequent pests. Loss estimates should then be made to rank the economic importance of the problems and to justify support of work.

8. Centralize and standardize the pesticide registration system within the central government. Each province and the central government now carries on its own testing and registration. This is an unwieldy system for the private sector and wasteful of local research talent. We have reviewed the central government ordinance No. F.24(1)71 on Ordinance No. II of 1971 which establishes registration at the central government level and eliminates provincial registration. This ordinance should be amended to give clear representation on the Agriculture Pesticide Technical Advisory Committee to technical persons in the various provinces and then

implemented as soon as possible. Consideration should be given to the formation of technical committees on a commodity basis in the provinces, on an integrated crop basis at the national level, to review, and advise on, pesticide registration matters.

9. Procurement, distribution and sales of pesticides and application equipment should be largely turned over to the private sector in all provinces. The system of government control of all aspects of the pesticide business is now unsatisfactory to all private sector companies and clearly will be unworkable as pesticide use expands. The Punjab has begun the process of turnover to the private sector. We believe the private sector should be given greatly increased control of procurement, distribution and sales (including application operations) in all the provinces. A greater private sector involvement in procurement will permit each company to purchase what is needed and instill in each firm a proprietary interest in its own products. It is realized that for very poor growers it may be necessary for the government to completely pay for the cost of the chemical and the application. Because of the desire to make quick profits and the low level of farmer education, close governmental supervision of the pesticide industry will be required to prevent exploitation of the farmer. Those engaged in private sector sales and in advisory services to farmers should be formally trained in plant protection. It is recommended that the system used in Turkey be considered as a model for regulation of the pesticide industry in 'stan.

GENERAL RECOMMENDATIONS FOR REGION

Agricultural scientists must be encouraged to remain in research and teaching. In most countries visited the morale of agricultural scientists was low and they felt their work was considered unimportant by society at large. This state of low morale was made apparent by comments about working conditions and low salaries, and by attitudes toward their work in general. Everything possible should be done to increase the morale of agricultural scientists so they will want to remain in their professions and increase their productivity.

Because agriculture is the economic base of the Near Eastern and South Asian nations and supplies most of the foreign exchange, governments should take steps to insure an adequate supply of well educated and highly motivated scientists in teaching and research. Some actions that could be taken are given below.

1. Salaries should reflect the importance of the work. Scientists were generally found to be underpaid. Taxi drivers and hotel bellhops were often cited as better paying positions. It seems unsound for any society to expend thousands of dollars to train a man as a scientist and then employ him at a salary as low as that earned by an unskilled laborer.

2. The public relations activities of agriculture should be increased to make the general public more aware of the value of agriculture to society. Everyone honors medical doctors and the medical profession expends much effort in public relations. Few people are yet aware of the value of an agricultural research station and its staff.

3. Professional plant protection societies and conferences should be encouraged and fostered in each country. The Plant Medicine Congress in Iran is an excellent example of what can be done in organizing a professional conference. Such activities provide a vehicle for broad relationships with government and related groups. They also provide for exchange of ideas and information among scientists, which is basic for progress in science, and serve as a forum wherein plant protection policy and work can be debated and coordinated.

4. Publication of research results should be encouraged. New data are continually needed by agriculture and the scientist needs the recognition that publication brings. Authorship of papers must be restricted to those researchers who have actually done the work. Too often a principal investigator has been relegated to junior author status by directors, department heads, or other administrators.

5. Refresher-type study programs should be instituted in each country. Science develops rapidly and if scientists are to remain properly trained they must be given opportunity to be brought up to date periodically. Every country has programs for the initial training of

scientists but little provision has been made to keep them highly trained. Study leave programs should be so organized that working scientists are given the opportunities; leaves for administrators should be separate programs.

Reference literature availability must be improved. All of the countries lack journal reference materials which are a vital part of an effective plant protection program. With very few exceptions, the problem was present regardless of the type of institution. Part of the problem is that much of the plant protection literature is published in English, which all workers cannot read. However, total unavailability is the more important aspect of the problem. The Team is certain that the situation will worsen as journals proliferate and increase in cost. Therefore, we recommend that USAID initiate a long-term program to alleviate the problem via one of the following options:

1. "Current contents" (reproduction of the title page of the principal plant protection journals) approach. A "current contents" publication on plant protection could be initiated by the contractor or by another agency such as a commercial publishing house. The publication might be sold in the U.S. and made available by AID to selected research centers in developing countries. Any reader could request reprints directly from authors whose addresses would appear in each issue.

2. Journal article reproduction service. A center could be established at a university in the U.S. which presently receives the major plant protection journals. This center would serve as a central address for requests from research workers in all developing countries. Articles would be copied from the journal and mailed to the research worker at minimal or no cost.

These approaches bear some resemblance to the East African Scientific and Technical Literature Service located at EAAFRO, Nairobi, Kenya, which was described in the East Asian Pest Management Study Team report. We rejected this "in country" approach because no library in our area of study even approached a level of holdings adequate to the task.

The second aspect of the reference problem is the dearth of plant protection textbooks. Several private collections are present but for understandable reasons these are not generally available. Therefore, we recommend that USAID develop the following programs:

1. A list of current textbooks in each of the major fields of plant protection be prepared and made available to institutions in developing countries. The list should include title, author, publisher, best source and cost, and should be revised periodically as usage or availability changes. USAID should also consider a program of textbook grants to selected institutions.

2. All professional plant protection societies should be contacted and regularly informed of the need for textbooks and journals in the

developing countries. Opportunities should be made available for retired research workers to sell, grant or give by will their personal libraries to the libraries of institutions of higher learning or research centers in developing countries. We think it important that such collections should be housed in institutions rather than with individuals. USAID should develop a program to finance the cost of shipment of such collections.

A third aspect of the reference problem is the unavailability of abstracting journals in the developing countries. Although we recognize the problem, we are unable to present any reasonable solutions.

Guidelines for pesticide registration in the developing countries should be prepared under USAID auspices. Much variation was found to exist in pesticide registration procedures in the countries visited. This varied from a rather sophisticated process in Turkey to practically none in Afghanistan. Appropriate labeling of pesticides lagged behind registration in all countries visited. Realistically, these nations recognize that their abilities to enforce regulations dictate to a large extent the type of registration and labeling procedures which are appropriate. All the nations visited have a real need for some pesticides, and if the private sector is the vehicle through which these materials move to the farmer, the private sector must be expected to realize a fair profit from the importation, manufacture, formulation, distribution, and sale of them. The Team believes that haphazard registration and labeling procedures serve as a serious deterrent to the private sector in any expected long-term venture, and actually jeopardizes the agriculture of a country due to creation of a lack of confidence in the future of pesticides there. However, we do not advocate a completely uncontrolled private sector, for there are too many opportunities for serious exploitation of small and large farmers alike.

The preparation of guidelines for registration and labeling procedures for use by governments in the developing countries would be of great assistance to orderly plant protection. No single set of guidelines will be suitable for all countries, however, and several alternate sets should be prepared to suit the varying levels of development of the countries concerned. In these guidelines, the purpose of, or basis for, each regulation should be made perfectly clear.

Guidelines for plant quarantines in the developing countries should be prepared under USAID auspices. In Afghanistan, the Study Team found a total absence of plant quarantine regulations. This state of affairs may not be unusual among the least developed nations. Yet with intercontinental, national, and local travel increasing, both in volume and speed, the likelihood of destructive pests, pathogens, and weeds finding their way into areas where they do not now occur is very great. Guidelines for plant quarantines would be most helpful to all levels of developing nations to forestall or reduce the likelihood of movement of these agents. Several alternate sets of guidelines should be prepared depending on the ability of any nation to enforce the proposed regulations. The biologic and economic bases of each guideline should be carefully documented in each case.

New training methods in the plant protection sciences should be explored. In many developing countries adequate capabilities now exist to train plant protection scientists and middle level technicians. Institutions such as Ankara University (Turkey), Karaj College and Pahlavi University (Iran) and West Pakistan Agricultural University can now meet many of the training needs of the countries in which these institutions are located, and beyond. Where training for the M.S. or Ph.D. degree in a particularly specialized area of plant protection is required, the candidate should be sent for course work to a U.S. or other developed country institution. However, the student should be returned to his home country for his thesis research.

It has become increasingly possible to have the degree awarded from a cooperating U.S. university on such an arrangement, if desired, particularly when a sponsoring agency such as USAID can provide for the U.S. major professor to travel to the student's home country at least annually to advise on the research work in progress. Such an arrangement could also be valuable in other ways to the sponsoring agency, in that the U.S. faculty member could serve usefully as a consultant in other plant protection matters during his visit. USAID or the contractor should begin discussions with U.S. institutions to learn which ones would subscribe to this arrangement.

Whether a researcher, teacher, or extension worker in a developed country has received his advanced degree at home or abroad, refresher-type postgraduate training programs in a developed country university or at such institutions as IRRI or CIMMYT are seen as an essential need. Only persons actively working should be sent, and it is expected that on completion of their refresher programs, they will return to their positions.

Attention must be given to inoperative scientific and other equipment. In many of the plant protection laboratories visited, as much as 90% of the laboratory equipment was inoperative because of broken or malfunctioning parts. In general, the original equipment appeared to be of good quality and had been purchased recently. Although some of the inoperative equipment is highly complicated and sophisticated, the vast majority is standard equipment used regularly in laboratories throughout the world. The same situation was found to exist with respect to field equipment used experimentally or by government workers in plant protection programs. In one large operation, it was reported that approximately 50% of the application equipment was broken down at all times.

Some factors which contribute to this serious situation are: 1) scarcity or unavailability of spare parts in many countries, 2) inability to purchase many spare parts from abroad because of scarcity of foreign exchange, 3) lengthy and complicated procedures involved in ordering spare parts from abroad, 4) scarcity of trained technicians to install and repair equipment, and 5) isolated locations of many plant protection laboratories thus making it difficult to locate the spare parts in a country and making it difficult or impossible for a maintenance technician

to travel to that laboratory.

It would aid this situation if only a very few brands of a particular kind of equipment were used in a country. However, a particular kind of equipment is usually supplied by a number of donor agencies and usually is manufactured in the donor country. More effective use of donor funds would result if USAID and other agencies would spend part of the funds now being used for purchasing new equipment to facilitate the maintenance of existing equipment and the purchase of spare parts for this equipment.

One possible way to do this might be by training and helping pay the salary of maintenance technicians in the developing countries. Of course, ways must be found to supply these technicians with spare parts. One solution might be to establish a regional center which would supply spare parts and prepare and disseminate maintenance instructions in the language of each country of a region. There is no easy and simple solution to this problem; however, the magnitude and importance of it requires that new and imaginative solutions be attempted.

Plant protectionists must look beyond chemicals for solutions to problems. Although the Study Team realizes the importance of chemical control, they concluded that of the research and extension activities in plant protection, too much effort was spent on chemical control at the expense of work on other control measures and integrated control. For control of pests and diseases on some crops chemical control is too expensive and is likely to remain so in the foreseeable future. Foreign exchange shortages make purchase of certain pesticides difficult or impossible in some countries. Many chemicals are too toxic to be applied by poorly equipped, uneducated workers. During this trip, a number of deaths due to pesticides were reported and it appears likely that large numbers of workers may have been injured while applying pesticides. For these and other reasons, pesticides should not be looked on as the answer to every pest control problem. On the other hand, at our present level of knowledge, the control of some important pests and diseases can be achieved only by chemicals. Also, in comparison to most other control measures, the research involved in finding a chemical control is inexpensive and can be carried out in a relatively short time. Thus, chemicals are suited to cope with emergencies.

Other control measures such as resistant crop varieties, cultural practices, and sanitation have a number of advantages in developing countries. For example, they usually are cheaper than chemical control, are safer for uneducated growers to use, and often provide good opportunities for employment of agricultural workers.

Plant breeding programs to develop resistant varieties require long-term continuity of effort and are best carried out by in-country scientists in cooperation with scientists from an international agency such as IRRI or CIMMYT. It is recommended that donor agencies such as USAID consider the support of additional long-range breeding programs designed to obtain crop varieties with resistance or tolerance to pests and

diseases. Also, it is urged that plant protection scientists in the countries visited spend more research time on controlling diseases and pests by cultural practices, sanitation, selection of the available varieties most resistant or tolerant to important pests and diseases, and on integrated control. When appropriate, such efforts should be supported by donor agencies.

SUBJECT MATTER RECOMMENDATIONS FOR REGION

A. Weed Science

In each of the countries visited, weed science was a secondary effort conducted primarily by people trained in another area of agricultural science. The work underway was often a herbicide testing program and invariably emphasized solving problems which had been only vaguely defined. Therefore, we recommend that weed science programs be initiated or redirected toward problem definition. Specific programs which should be included are:

1. The identification of problem weed species by crop and region.
2. Weed competition studies to show:
   a) the density of a particular weed species or weed complex that causes economic loss
   b) the critical time(s) of weed competition during the crop season
   c) the yield reduction in weedy vs. weed-free stands.

Herbicides offer certain advantages to the farmer, but the size of farms, education of farmers, lack of application equipment, and an abundance of labor all argue against their widespread application at this time. For the near future herbicide development should emphasize crop and human safety more than broad range phytotoxicity. After the weed problems have been adequately defined and other yield improvement inputs reach a level where weeds become limiting, herbicides should be judiciously employed as a tool in the quest for higher agricultural production.

Implicit in this recommendation is the need for research workers, at all levels, specifically trained in weed science.

B. Nematology

In important agricultural areas of each country the high temperatures, types of crops grown, and the cropping systems--including the growing of several crops per year--provide strong reasons to believe that nematodes and nematodes in association with soil fungi and bacteria are causing considerable damage to crop plants. No nematology problems have been identified in Afghanistan and only some of the more obvious nematode-induced diseases have been recognized in Turkey, Iran, and Pakistan. Thus, the greatest overall research need in nematology is to identify

nematode problems and determine crop losses caused by them. In general, only after a nematode problem is identified and it is established that it causes crop losses should research be conducted to develop control measures. Eventually research must be conducted on interactions between nematodes and soil microorganisms and on virus transmission by nematodes.

Greenhouses with reasonable temperature control are needed for certain aspects of all the suggested research but only 1 or 2 functioning greenhouses were noted in the 4 countries. A consultant from the U.S.A. or another developed country should aid in developing plans for a greenhouse or similar structure for growing plants which could be used for most of the year. Its original cost and maintenance must not be expensive. Ways to facilitate maintenance and procurement of spare parts for laboratory and field equipment are also needed. In addition, steps should be taken to make current nematology literature more readily available to teachers, researchers and extension workers.

The following are the most urgent needs of each country. Afghanistan: a well-trained nematologist to work full time on nematology problems and at least 1 well-equipped laboratory in which to work. Pakistan: several well-trained nematologists to devote full time to nematology and several well-equipped laboratories exclusively for nematology work. Turkey: refresher study programs for active nematologists at universities outside of Turkey with good nematology programs. Iran: employment of additional nematologists and means to enable the establishment of an M.S. and eventually a Ph.D. program in nematology for Iranians and students from other countries. Student graduate programs should be directed by nematologists rather than entomologists or plant pathologists.

C. Plant Pathology

The development and functioning of plant pathology varied from country to country in the region visited. Because of the availability of educated personnel, institutions and facilities, Iran and Turkey are best capable of moving rapidly ahead with comprehensive disease control programs. Afghanistan is least prepared for work in plant pathology and Pakistan is at an intermediate stage.

The need for qualified personnel is less acute in Iran and Turkey but in Pakistan and Afghanistan it is probably the major factor limiting progress. Educational assistance to Turkey and Iran could be limited to postdoctoral studies; in Pakistan it could be limited to pre- and postdoctoral training; in Afghanistan it should cover all aspects of graduate work because it is not available in the country. The University of Kabul also needs considerable foreign help just to maintain the University for undergraduate education.

No program in plant pathology extension was seen in any of the countries visited. The organization for such work exists in Turkey, Iran and Pakistan but there were few qualified workers active.

In each country there is an urgent need to fully coordinate the research, education, and extension work in plant pathology because of the pressing problems and the minimum number of qualified personnel and facilities available. If these activities were coordinated fully at every level of organization, no important aspect of plant disease would be neglected.

Each organization visited needs improved financial support for plant pathology. This need was reflected in complaints about poor salaries, the presence of equipment needing repair, the lack of ordinary equipment for routine work, and in the absence of qualified middle-level technicians.

While many projects need to be undertaken in all countries, the most obvious need is to determine the most important diseases of the major crops by systematic surveys and experimental determination of the losses caused by them. There was too much tendency to work on diseases caused by fungi because they are so conspicuous.

D. Entomology

Relative to other plant protection sciences, entomology was generally found to enjoy preferential treatment in terms of scientific manpower for research and budgets for teaching and extension. This is not to imply that manpower or budgets for entomologically-related activities were adequate in all countries visited, or that there were no field problems of importance left unsolved. It does point out the greater visibility of insect-caused losses as compared to those caused by plant diseases, nematodes, or weeds.

As was the case in the developed countries until relatively recently, most of the activity in insect control in Turkey, Iran, Afghanistan and Pakistan revolves around chemical control. While there is no question but that a chemical treatment is the quickest, easiest, and most widely adaptable form of control in the short run, it must be remembered that agricultural exports contribute the majority of the foreign exchange to most of the countries visited. Escalating costs of pest control due to resistance, pest resurgence, and secondary pest outbreaks will in due course threaten this source of income unless a broader base of insect control is developed. The speed with which these pest control costs will escalate will conform to the speed with which chemical control is embraced by a majority of the farmers within a given geographic area on a single crop.

The Study Team was pleased to note in all countries that integrated control was a part of the thinking of the entomologists visited. Yet nothing to very little has been accomplished to date, and it is essential that this need be given greater attention. We believe that in Turkey, Iran, and Pakistan a program of postgraduate training for already active scientists is the means by which integrated control can be given a thrust forward most expeditiously. In Afghanistan needs in entomology are much

more basic than this and additional degree training is recommended.

In connection with the operational use of pesticides in the countries of Turkey, Iran, Afghanistan and Pakistan, the Team recommends that the use of DDT and many other chlorinated hydrocarbon insecticides be retained for specific uses. The trend toward abandonment of these compounds in the developed countries is most unfortunate, for the alternatives are often far more hazardous to handle, are much more inclined to disrupt the agricultural ecosystem, and are more costly. Whereas the developed countries can afford to change to shorter-residual insecticides and have ready access to alternatives which can be applied safely by skilled personnel, most of the developing countries cannot pursue this course without hardships.

TURKEY

Date	City	Agency and Persons Contacted	Team Member(s) Involved	Nature of Discussions
Sept. 6	Ankara	USAID L. Otto, Food and Agr. Afficer K. Byergo, Deputy Food and Agr. Officer H. Hepworth, Oregon State U., Cereals Production Team Leader	Wilcoxson Mai Zimdahl Koehler	Briefing on plant protection in Turkey
		Plant Protection and Plant Quarantine Directorate, Ministry of Agriculture, 98 Nejati Bey Cad. Ramiz Sipahi, Deputy Director General Ismail Senturk, Asst. Director General Aslan Karabagli, Dir. of Quarantine Section Burhan Baysec, Dir., Extension Section Cevdet Sevintuna, Dir., Pesticide Section	Wilcoxson Mai Zimdahl Koehler	Organization and functions of Directorate
Sept. 7	Ankara	Wheat Research & Training Center, P.O. Box 226 B. C. Wright, Agric. Project Leader Ahmet Demirlimakmak, Head, Wheat Program Necmittin Yildrin, Entomologist	Mai Koehler	Programs of Center; problems of wheat
		Bölge Zirai Mücadele Arastirma Enstitüsü Ali Riza Leventoglu, Director, and Staff	Mai Koehler	Organization and programs of regional plant protection institute
	Samsun	Bölge Zirai Mücadele Arastirma Enstitüsü Rahmi Hazneci, Director (Entomologist) Ossman Ozbas, Plant pathologist Senyurer Mumim, Vegetable pathologist Olcum Kamuran, Vegetable pathologist Suna Altinyay, Industrial pathologist & ornamentals pathologist Orhan Bilgun, Cereal pathologist Enis Erkin, Cereal pathologist	Wilcoxson Zimdahl	Programs of regional plant protection institute

TURKEY (continued)

Date	City	Agency and Persons Contacted	Team Member(s) Involved	Nature of Discussions
Sept. 7 (contd.)		Fikret Dundar, Plant pathologist, fruits Necati Altinyay, Plant pathologist, fruits Ozdmir Hancidelu, Plant pathologist, fruits Yusuf Zaurak, Vegetable pathologist Ayhan Bora, Vertegrate pest control and nematologist Ismail Korlcut, In-charge, weed control section Mustafa Kasa, Weed control lab.		
Sept. 8	Samsun	Bölge Zirai Mücadele Arastirma Enstitüsü (continued - see above)	Wilcoxson	See above
	Izmir	Faculty of Agriculture, Ege University Ulku Yorganci, Virologist Ilknur Zuhal, Weed scientist Ersin Onogur, Asst. in Plant Pathology	Mai Koehler	Teaching and research in plant protection
		Sandoz Kinya San. Ltd. Sti., 1328 Sokak, No. 7 Nelson Arditti, Economist	Mai Koehler	Pesticides in private sector
		Bölge Zirai Mücadele Arastirma Enstitüsü Necati Kaskaloglu, Director Mine Tuncyurek, Biological control lab. Hüsayin Erturk, Nematologist	Mai Koehler	Programs of regional plant protection institute
Sept. 9	Istanbul	Bölge Zirai Mücadele Arastirma Enstitüsü, Erenköy M. Ali Anbaroglu, Director, and staff Nebih Yalaz, Director General, Plant Protection and Plant Quarantine, Min. Agric., Ankara	Zimdahl Mai Wilcoxson Koehler	Programs of regional plant protection institute. Programs of Directorate.
Sept. 11	Istanbul	Hektas, Ticaret T.A.S., Kemeralti Cad. No. 65, Tophane Mustafa Sipahi, Director General	Wilcoxson Mai	Pesticides in private sector

TURKEY (continued)

ate	City	Agency and Persons Contacted	Team Member(s) Involved	Nature of Discussions
ept. 11 (contd.)		Bayer-Tarim Ilaclari Sanayi Ltd. Sti., Kemankes Cad. No. 231-233 Kat 2, Tophane Necdet Kücükkoca, Gen. Manager and Staff	Zimdahl Koehler	Pesticides in private sector
		Shell Company of Turkey Ltd., Buyukdere Cad. Nevtron Han, Gayrettepe Aziz Tanrisever, Agric. Market Mgr.	Zimdahl Koehler	Pesticides in private sector
ept. 12	Ankara	Ankara Universitesi, Ziraat Fakultesi, Bikti Koruma Kürsüsü Abdullah Gurcan, Virology, Weed Science Necati Baykal, Bacteriologist Gursel Erdiller, Virology Von O. Yegen, Weed science Zeliha Düzgünes, Entomology Mustafa Ozer, Entomology-Stored Products Akif Kansu, Entomology-Lepidoptera Seval Tovos, Entomology-Aphids Neset Kilincer, Entomology-Parasitology Bahattin Kovance, Entomology-Biology Vifan Tune, Entomology-Thrips	Zimdahl Koehler	Teaching and research in plant protection
		Sugar Institute, Etimesgut Orhan Tokmakoglu, Entomologist Mehmet Göbelez, Plant Pathologist Göksar Onat, Entomologist Sahap Barker, Soil Chemist	Zimdahl Koehler	Sugar beet plant protection

TURKEY (continued)

Date	City	Agency and Persons Contacted	Team Member(s) Involved	Nature of Discussions
	Diyarbakir	Bölge Zirai Mücadele Arastirma Enstitüsü A. Ulvi Kilic, Director Yasar Parlak, Cereal pathologist Avni Babalak, Tree fruit pathologist Mustafa Zel, Weed Scientist S. Yildirin Dürtbudak, Entomologist	Wilcoxson Mai	Programs of regional plant protection institute
Sept. 13	Adana	Bölge Zirai Mücadele Arastirma Enstitüsü Nedim Tekinel, Virologist Muzaffer Agdall, Nematologist Mehmet Bicici, Weed Scientist Necmettin Dinc, Plant Pathologist Kamil Telbaga, Plant Pathologist Hamit Benli, Entomologist Zoli Soylu, Entomologist Turget Süzer, Entomologist Hasen Salik, Plant Pathologist	Wilcoxson Zimdahl Mai Koehler	Programs of regional plant protection institute
		Adana Universitesi, Ziraat Fakultesi Kemal Gokce (Dean), Microbiologist I. Akif Kansu, Entomologist Nedim Uygun, Entomologist Ahmet Cinar, Plant Pathologist Ozden Cinar, Plant Pathologist Mehmet Yilmaz, Plant Pathologist	Mai Zimdahl Wilcoxson Koehler	Teaching and research in plant protection
		Hercules Inc. Yusuf Kiray	Wilcoxson Mai Zimdahl Koehler	Pesticides in private sector

TURKEY (continued)

Date	City	Agency and Persons Contacted	Team Member(s) Involved	Nature of discussions
Sept. 14	Ankara	Plant Protection and Plant Quarantine Directorate, Ministry of Agriculture, 98 Nejeti Bey Cad. Nebih Yalaz, Director General Ramiz Sipahi, Deputy Director General Cevdet Sevintuna, Dir., Pesticide Section	Zimdahl Wilcoxson Koehler	Pesticide usage and consumption in Turkey
		USAID Leonard Otto, Food and Agric. Officer Homer Hepworth, Oregon State University Cereals Production Team Leader William Davis, Agriculture Attaché	Wilcoxson Mai Zimdahl Koehler	Predeparture debriefing

IRAN

Date	City	Agency and Persons Contacted	Team Member(s) Involved	Nature of Discussions
Sept. 16-17	Shiraz	Department of Plant Protection, College of Agriculture, Pahlavi University Sadreddin Sharifi, Entomologist (Dept. Head) Cyrus Abivardi, Nematologist Ahmad Askari, Entomologist (bio. control) Ziaeddin Banihashemi, Plant Pathologist Javad Fatema, Plant Pathologist	Mai Wilcoxson Koehler	Teaching and research in plant protection
Sept. 16-18	Andimeshk and environs	Khuzestan Water and Power Authority Project D. P. Gowing, Advisor to Haft-Tappeh Cane Sugar Project N. Bamiabhasi, Haft-Tappeh Sugarcane Project Massmeh Behrooz, Dezful Irrigation Project Ahmad Vaziri, Dezful Irrigation Project Majid Shishigar, Dezful Irrigation Project Mehdi Yazdi, Dezful Irrigation Project Development and Resources Corporation Richard Fine, Weed Scientist Wheeler Calhoun, Crops Advisor John Vaughn, Consultant to Station Director Agro-Industry Personnel Mohammad Fatoreh, Agro-Industry of Iran and America I. Forootan, Iran California Company Richard T. Ward, Iran California Company Plant Pests and Diseases Research Institute, Ahwaz M. Jaxayeri	Zimdahl	Plant protection in large-scale agricultural schemes in Iran
Sept. 18	Tehran	Plant Pests and Diseases Research Institute, Ministry of Agriculture, Evin E. Esfandiari, Director B. Amani, Bacteriologist D. Ershad, Plant Pathologist Mastafa Mostafaway, Virologist Okbar Shahidi, Plant Pathologist	Wilcoxson Mai	Federal programs in plant protection research

Date	City	Agency and Persons Contacted	Team Member(s) Involved	Nature of Discussions
Sept. 18 (contd.)		F. Ebrahim-Nesbat, Virologist M. Foroughi, Plant Physiologist Y. Rahmani, Plant Pathologist B. Danesch, Plant Pathologist Mr. Borumand, Entomologist A. Abbaspour, Nematologist		
		U.S. Embassy Alexander Rattray, Economic Development Officer M. Ali Ellini, Economic Advisor (Agr.)	Koehler	Local arrangements
		German Development Aid, c/o Botschaft der BRD, P.O. Box 48, Evin Manfred Hille, Project Manager	Koehler	Programs of German Development Aid in Iran
		CENTO, P.O. Box 1928 Geoffrey R. Ames, Scientific Secretary	Wilcoxson Mai Koehler	CENTO programs in greater Mideast
Sept. 19	Tehran	Faculty of Agriculture, University of Tehran, Karaj A. Davatchi (Dean), Entomologist Samadi Vojdani (Vice Dean), Entomologist Mahmoud Shodjai, Head, Plant Medicine Dept. Farinar Eskandavi, Plant Pathologist Dr. Khairi, Nematologist	Wilcoxson Mai Koehler	Teaching and research in plant protection
		KBC Co., 247 Naderi Avenue F. Moghbelin, Sales Manager	Zimdahl Koehler	Pesticides in private sector
		Shell Chemical Services (Overseas) Ltd., Shell House, Abbassabad Avenue, Mazara Crossroad D. F. Russell, Regional Agr. Dev. Manager	Mai Wilcoxson	Pesticides in private sector

IRAN (continued)

Date	City	Agency and Persons Contacted	Team Member(s) Involved	Nature of Discussions
Sept. 19 (contd.)		U.S. Embassy M. Ali Ellini, Economic Advisor (Agr.)	Zimdahl Koehler	Check out

ıte	City	Agency and Persons Contacted	Team Member(s) Involved	Nature of Discussions
;pt. 20	Kabul	USAID John R. Wilson, Food and Agriculture Officer Jerry Rann, Plant Protection Advisor	Wilcoxson Zimdahl Mai Koehler	Briefing on plant protection in Afghanistan
		Ministry of Agriculture Abdullah Faiyzar, President of Extension	Wilcoxson Zimdahl Mai Koehler	Organization and function of extension service
;pt. 21	Jalalabad	Regional Research Station, operated by Ministry of Agriculture. Accompanied by Jerry Rann and Henry Wiggin, AID Plant Breeder	Zimdahl Mai Wilcoxson Koehler	Field trip to observe field problems on citrus, maize, rice, vegetables, cotton
;pt. 23	Kabul	Ministry of Agriculture M. A. Sadeq, General Director of Plant Pest Control Mohammad Yasin, Plant Protection Officer	Mai Koehler	Programs in plant protection
		Indian Technical and Economic Cooperation Team, Embassy of India Z. A. Siddiqi, Entomologist S. B. Lal, Virus Pathologist	Mai Koehler	Indian technical aid in plant protection in Afghanistan
		Darulaman Experiment Station, Ministry of Agriculture Ghulam Sakhi Ahmadi, Plant Pathologist Sahib Dad, Director and Agronomist	Zimdahl Wilcoxson	Crop science research

AFGHANISTAN (continued)

Date	City	Agency and Persons Contacted	Team Member(s) Involved	Nature or Discussions
Sept. 23 (contd.)		Plant Protection Association of Afghanistan meeting Z. A. Siddiqi, Entomologist, Indian Agric. Team R. S. Narang, Agronomist, Indian Agric. Team S. B. Lal, Virus Pathologist, Indian Agric. Team Marcel Jelaska, Viticulturist, FAO/PACCA Gulbuddin Sharifi, Entomologist, Kabul University Azam Gul, Agronomist, Kabul University Lewis C. Saboe, Plant Science Advisor, Kabul Univ. James Cullen, Entomologist, WHO Malaria Program M. Y. Saaed, Importer, Saaed Ind. Co., Ltd. A. Wais, Plant Protectionist, Bayer Co. Mr. Toepffer, Bayer Co. Aziz Ansary, ICI Co. M. K. Hingorani, Plant Protectionist, FAO Abdullah Faizyar, Pres., Extension Dept. Jerry Rann, Entomology Advisor, USAID	Wilcoxson Mai Zimdahl Koehler	Assorted topics in plant protection
Sept. 24	Kabul	Saaed Industrial Co., Ltd. M. Y. Saaed, Managing Director	Wilcoxson Zimdahl	Registration of pesticides
		Faculty of Agriculture, Kabul University S. Ah. Fazly, Dean Azim Gul, Plant Breeder G. Sharafi, Entomologist	Wilcoxson Zimdahl	Teaching and research
Sept. 25	Baghlan	PACCA Project Peter Myers	Koehler	Plant protection in wheat, cotton, sugar beets
	Lashkar Gah	USAID David Levintow, Director Roy Miller, Extension Advisor	Zimdahl Wilcoxson	Plant protection activities

AFGHANISTAN (continued)

Date	City	Agency and Persons Contacted	Team Members Involved	Nature of Discussions
Sept. 26	Kunduz	Cotton Research Station Mr. Tibo, French AID	Koehler	Plant protection in cotton
		Ministry of Agriculture Shah M. Shirzai, Director Gen., Kunduz Province	Koehler	Agriculture and pest problems in Kunduz Prov.
	Lashkar Gah	USAID Richard Scott, Sociologist	Zimdahl Wilcoxson	Plant protection activities
		HAVA Project, Marja area Abdul Karim Barik	Wilcoxson Zimdahl	Extension work
Sept. 27	Kandahar	HAVA Project, Kandahar area Mr. Amidin, Extension leader	Wilcoxson Zimdahl	Extension pro-programs in plant protection
Sept. 30	Kabul	USAID John R. Wilson, Food and Agriculture Officer Jerry Rann, Plant Protection Advisor	Mai Zimdahl Wilcoxson Koehler	Predeparture debriefing

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Date	City	Agency and Persons Contacted	Team Member(s) Involved	Nature of Discussions
Oct. 2	Islamabad	USAID Floyd J. Williams, Agricultural Research Advisor	Wilcoxson Zimdahl Mai Koehler	Introduction to Pakistan plant protection
		Ford Foundation Gordon McLean, Chief Advisor Carl Gotch, USAID Economics Consultant	Wilcoxson Zimdahl Mai Koehler	Pakistan agriculture
Oct. 3	Peshawar	Directorate of Agriculture, Northwest Frontier Province Abdul Mannan Khan, Director of Agric. Ahmad Ullah, Plant Protection Officer	Wilcoxson Zimdahl Mai Koehler	Functions of directorate
		Agricultural Research Institute, Tarnab Moh'd Rashid Khan, Entomologist Mohib Ullah, Plant Physiologist Mohammad Aslam, Plant Pathologist	Zimdahl Mai Wilcoxson Koehler	Plant protection problems in NWFP
Oct. 4	Lahore	Agriculture Dept., Government of Punjab Muhammad Ameer Ali, Secretary of Agriculture Majid Hasan Khan, Joint Secretary Agriculture Musahibuddin Khan, Director of Agriculture Gulam Qadir, Director, Plant Protection Institute (Lyallpur) A.S.K. Ghouri, Deputy Director Plant Protection Mohammad Ali Bajwa, Plant Protection Officer	Mai Zimdahl Wilcoxson Koehler	Organization and function of provincial plant protection offices. Pesticides.
		Dawood Corp., Ltd., 416 Alfalah Bldg. Khawja Aman Ullah, Director General Dr. Rafiq, Chemist Aziz Moon	Wilcoxson Zimdahl	Pesticides in private sector

PAKISTAN (continued)

Date	City	Agency and Persons Contacted	Team Member(s) Involved	Nature of Discussions
Oct. 4 (contd.)		Jaffer Bros. Ltd., 3, Mall Mansion, 30, Shahrah-E-Quaid-E-Ezam Mohammad Anwar, General Manager A. Samad Chinoy, Director Irshad Ahmad, Manager	Mai Koehler	Pesticides in private sector
		Directorate of Agriculture, Government of Punjab, 6-A Jail Road Musahibuddin Khan, Director of Agriculture	Mai Zimdahl Wilcoxson Koehler	Extension activities in plant protection
Oct. 5	Lyallpur	West Pakistan Agricultural University Abdul Ghafoor Kausar, Dean, Faculty of Agriculture M. Yunas Chaudhry, Head, Dept. of Entomology Mohammad Aslam, Plant Breeding and Genetics Abdul Hamid, Plant Pathologist Inam Ullah Khan, Plant Pathologist	Zimdahl Wilcoxson Mai Koehler	Teaching and research in plant protection at university
Oct. 6	Lyallpur	Punjab Agric. Research Institute Sana Ullah and Staff	Mai Wilcoxson Zimdahl Koehler	Organization and functions of institute
		Plant Protection Institute Gulam Qadir and Staff	Mai Wilcoxson Zimdahl Koehler	Functions of institute; pesticide standardization
Oct. 7	Multan	Cotton Research Institute Mehboob Ali, Director, and Staff Zahoor Ahmad, Entomologist	Zimdahl Mai Wilcoxson Koehler	Plant protection research in cotton

PAKISTAN (continued)

Date	City	Agency and Persons Contacted	Team Member(s) Involved	Nature of discussions
Oct. 7 (contd.)		Department of Agriculture, Multan Division Sharif Ahmad Khan, Deputy Director, Agriculture	Wilcoxson Mai Zimdahl Koehler	Extension and pesticide application practices in plant protection
Oct. 8	Lahore	Malik Khudda Baskh Bucha, Agric. Advisor to President of Pakistan Norman Borlaug, Head, Wheat Program, CIMMYT Gordon McLean, Ford Foundation Chief Advisor	Wilcoxson Mai Zimdahl Koehler	Philosophy of agricultural development; GOP policies in plant protection
Oct. 9	Lahore	Government Rice Station, Kala Shah Kaku Dr. Majid, Acting Rice Botanist I. A. Dar, Entomologist M. Rafiq, CIBA-Geigy M. Saeed, Plant Pathologist M. A. Khan, Cereals Pathologist, Murree	Zimdahl Wilcoxson Koehler	Plant protection research in rice
Oct. 10	Rawalpindi	Commonwealth Institute of Biological Control, Murree Road M. A. Ghani	Koehler	Biological control research
	Islamabad	Government of Pakistan Secretariat, Block B M. Abdullah, Agr. Development Commissioner	Koehler	Central government activities in plant protection
		USAID Joe Wheeler, Director Bill Wolffer, Deputy Director Leon Hesser, Food and Agr. Officer Floyd Williams, Agr. Research Advisor	Koehler	Predeparture debriefing

PAKISTAN (continued)

Date	City	Agency and Persons Contacted	Team Member(s) Involved	Nature of discussions
Oct. 10 (contd.)	Karachi	Dept. of Plant Protection, Government of Pakistan, Jinnah Ave., Malir Halt Heshamul Huque, Director General	Mai Zimdahl	Activities of Central Plant Protection
		Pakistan Burmah Shell, Ltd., Agric. Chemicals Dept., P.O. Box 4712 R. M. Bokhari, Chemicals Manager A. H. Junaid, Entomologist	Mai Zimdahl	Pesticide use, sales and policies in Pakistan
Oct. 11	Karachi	Jaffer Bros. Ltd., 1/29 Shireen Manzil, Randall Rd. Yusuf E. H. Jaffer, Managing Director S. I. Waris, General Manager Mansoor Ahmad, Entomologist	Zimdahl Mai	Pesticides in Pakistan